FINAL REPORT

MARKET VALUE OF AGRICULTURAL WATER LEASED FOR INSTREAM FLOWS

Report to Montana Department of Fish, Wildlife and Parks

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EXECUTIVE SUMMARY

Objectives, Scope and Organization

The purpose of this report is to provide market values for leasing agricultural water for instream flow purposes and to develop a structure for lease agreements. This information is to assist Montana Department of Fish, Wildlife and Parks (DFWP) in implementing House Bill 707 which provides for the development of a pilot instream flow water leasing program. The agency can lease water rights for the purpose of maintaining or enhancing streamflow for the benefit of fisheries. DFWP has received approval to investigate potential leases at two sites in southwest Montana: Swamp Creek in the Big Hole drainage near Wisdom and Big Creek in the upper Yellowstone drainage near Emigrant.

The specific tasks addressed by this report are as follows:

I. Economic Value of Instream Flows.

A. Collect and summarize the available information regarding the economic value of agricultural water which has been sold or leased for instream flows in other states and the methods used to determine these values.

B. Based on (A), propose methods for calculating a defensible fair market price for leasing agricultural water for instream uses in Montana. Fishery benefits should not be considered in these calculations.

C. Following approval of the methods by DFWP, compute the range and the average prices for leasing water (in dollars per acre-foot and dollars per cfs) that is currently used to irrigate alfalfa, wild hay and small grains using direct gravity diversions and sidewheel and center pivot sprinkler irrigation methods for the following counties: Beaverhead, Broadwater, Deer Lodge, Jefferson, Lewis and Clark, Meagher, Park and Ravalli.

II. Value of Potential Big Creek and Swamp Creek Leases.

A. Collect and summarize the specific information that is needed to derive the value of leased water for Big Creek and Swamp Creek sites now under investigation.

B. Using the approved methods, develop defensible, fair market values for leased water at the two sites.

III. Structuring Lease Agreements.

A. Meet with DFWP and, separately, with at least two (2) potential lessors to determine important issues which need to be addressed by a lease, including contractual parameters. Conditions or other steps needed to ensure that a lease does not harm the interests of other appropriators must also be addressed.

B. Summarize the various types of lease options, including, but not limited to flow amount, period of use, payment schedule, length of lease and monitoring.

The structure of this report follows this task outline. After an introductory section (1) and a review of the economics literature on valuing irrigation water (2), Section 3 provides a summary of actual water market transactions (Task I.A.). Section 4 proposes specific methods for this application (Task I.B.). Section 5 describes the county and crop specific water valuation results using the general methods (Task I.C.).

The potential value of the Swamp Creek and Big Creek leases is provided in Sections 6 and 7 respectively (Tasks II.A. and II. B.).

The structure of lease agreements is discussed in Section 8 (Tasks III.A. and III.B.). Section 8 actually goes beyond the scope of these tasks and provides draft lease language for many of the specific lease options. The latter was Task III.C. in the original scope proposed by DFWP.

Section 9 provides an integration of the economic and legal components by examining the implications of specific lease provisions for lease cost. Section 10 provides conclusions. Appendix A. describes the mathematical procedure for converting acre-foot values to a cubic feet per second (cfs) basis.

The primary authors of the economics section are John Duffield and Chris Neher. Mark Josephson and Richard Josephson authored Section 8. Specific information on the two potential leases was obtained through meetings with Fred and Jack Hirschy in Wisdom on September 21, 1990 and with Bruce and Connie Malcolm and John Ragsdale on September 23 in Emigrant. Ernie Harvey, a dairy farmer in the Bitterroot Valley, also participated in these meetings.

Theoretical Overview

With regard to the basic economics tasks there are two general cases upon which agricultural water valuation can be based. First is the case of foregone agricultural production resulting from the change from irrigated to nonirrigated cropland. The

second case is that which arises when there is an increase in the supply of water due to an increase in irrigation efficiency, or construction of a public work such as a reservoir. We will discuss the case of foregone production first.

Before proceeding to that case, we need to make a few observations about market structure. Agriculture is a relatively competitive industry and irrigation withdrawals account for the greatest share (96%) of water withdrawals in Montana (Gibbons, 1986). Given this competitive market setting, the demand side for the case of displaced agricultural production could be highly elastic and therefore dominate price. Alternatively, for the case of augmented quantity supplied, cost considerations may dominate price where the scale of investment is large relative to the market. However, the latter situation implies a monopoly will exist in the given market. Even for the demand side case, there is not a single unified water market in existence in Montana and perhaps never would be given the spatial limitation due to water transport costs. Accordingly, from a market structure perspective, for any given stream the situation may be better characterized as monopolistic or oligopolistic (few sellers) on the seller side and a monopsony (DFWP) on the buyer side. The basic result from these types of concentrated markets is that price is indeterminate. This is one way of saying that the actual market price in these spatially limited markets is going to be the result of negotiation or bargaining. Accordingly, the values we compute are not "market prices" *per se* but points of departure in the bargaining process.

Valuation Based on Displaced Production

The value of a given diversion depends not only on the quantity of water diverted but also on the quantity and quality of the land base, rainfall, crop types, type and efficiency of irrigation system and other inputs such as labor, power, and management (irrigation scheduling) peculiar to the land to which the water right is assigned. The following is an example of the radical influence which overall irrigation efficiency alone can have upon acre/foot water values.

Example: Overall efficiencies of irrigation systems can range from approximately 10% to 75%. If an acre/foot of water at the crop yields $100 then the value at the diversion (depending on efficiency) could be anywhere from $10 to $75 acre/foot.

Because of this instability of acre/foot water values it is better to work from a land base (value of water per acre) to get the total value of a diversion. This example also illustrates the need for site specific hydrological investigations.

County-level Comparison Method of Water Valuation

A good reference point for valuing a potential agricultural water lease is estimation of the net return to the irrigated land that would be taken out of production. We estimated this value by comparing yields on irrigated and nonirrigated cropland. Our data base was actual county-level historical production data for 1980-1988 in eight Montana counties, collected by the Montana Agricultural Statistics Service. This approach provided water value estimates for most crops in most counties. Where there was either no irrigated or no nonirrigated production of a crop within a county, estimates of water value could not be derived. Where the value estimates are based on small acreages the estimates may be unreliable and are noted as thus in the text.

Because on average irrigated cropland may tend to be higher quality soils than nonirrigated, the county-level comparison values should represent the average upper limit to agricultural water values. Note that these water values are just that - averages. Site specific values could vary considerably depending on the site characteristics (as noted above) and the actual net irrigation water available to the plants. A factor which is difficult to quantify and will vary considerably from site to site is ground water which is available to deep rooted plants like alfalfa. Additionally, actual site specific values will depend on a given farms economic situation and whether the farm can forego the production on their complex. For example, vertical integration or further processing of crops on site (feed or milling) and also crop rotation practices will effect the actual value to a given farm.

Because it is impossible to predict precisely the extent to which a crop in a certain area is meeting it's maximum water needs it is best to use site specific yields where possible. Also in general given uncertainty over the actual amount of water used by a given crop, it is better to start with values derived from the amount of land irrigated. The average county-level comparison approach is such a method. This is preferable to starting with a water based value (per acre/foot of water used).

Table E1 shows a comparison of per acre short run water values by crop and county. Short run value means that only the variable costs of production such as labor or pumping costs are deducted from gross crop revenue. In the long run, the net value would also be reduced by the amount of major investments in equipment or the ditch system. The point of distinguishing short run and long run here is that they correspond in a general way to the appropriate price as a function of lease term. A farmer who leases irrigation water on a short term lease is stuck with his investment cost. Accordingly, on a short term lease he is out the difference of his gross crop revenue and the costs he can control in the short term (for example, labor and power use that

varies with irrigation). By contrast, a long term water lease provides the lessor the opportunity to forego investment costs associated with irrigation as well as variable costs.

The range across crops and counties shown in Table E1 is due to three primary factors - yields, prices, and water availability. The variation across counties for a given crop is primarily due to the yield difference associated with irrigation in that county. Other things equal, counties with relatively high rainfall, such as Park county, will show crops benefiting less from irrigation. There also appears to be systematic differences across counties in terms of water availability to the crop. This is a function of water supplies, soil types, and average conveyance and application efficiencies (see the detailed discussion below in Section 5).

The differences across crops for a given county appear to be mainly a function of yields and prices. For example in Broadwater county, the bushels per acre extra yield due to irrigation is similar for the three major small grains: barley, oats, and spring wheat with yield differences of 33, 43 and 35 extra bushels per acre respectively. (Note that this detailed information for each crop and county is provided in Tables 5-58 in the main report below.) However, while oat and barley prices are similar for 1987-1989 ($1.73 and $2.23 per bushel respectively), the value of spring wheat is relatively higher ($3.49/bushel). As a result the short run net value for oats and barley in Broadwater are similar at around $65/acre, while spring wheat values are almost double at $112 (Table E1).

Again looking at Broadwater as an example, for the hay crops, alfalfa and "other hays", prices are similar per ton (65 and 58 dollars/ton for Montana 1987-1989 average) but alfalfa production is much more responsive to irrigation with a yield difference in Broadwater of 2.23 tons/acre versus only a .7 tons/acre difference with "other hays". Accordingly, the net value per acre due to irrigation of alfalfa in Broadwater ($125) is much higher than the value to irrigating other hays ($21). These net values of course also reflect estimated production costs as described below.

Table E1
Short Run Per Acre Water Values
By Crop and County

County	Alfalfa	Barley	Oats	Oth.Hay	S.Wheat	W.Wheat
Beaverhead	119	61	-	15	106	19*
Broadwater	125	66	65*	21	112	74
Deer Lodge	80	67*	-	-	37*	-
Jefferson	87	55	60*	10	33*	-
Lewis & Clk	101	52	55*	14	93	-
Meagher	68	48	35*	7	29*	-
Park	51	42	43*	19	27*	51*
Ravalli	100	64	69*	44	125	6*

Note: The values are based on the assumption of the use of flood irrigation and summarize Tables 23 to 28. Cells marked with an asterisk are estimates based on a small acreage sample,and thus may be unreliable.

In order to compute dollar values per acre foot from the dollar per acre values of Table E1, it is necessary to know how much irrigation, on average and by county and crop, was actually applied 1980-1988. This value is not known. For purposes of completeness, we illustrate in the main report that follows, values per acre foot derived from Table E1 on the assumption that sufficient irrigation is available to meet the maximum plant needs for a given site and climate. This has the effect of understating acre foot values if maximum plant needs are not met. Additionally, we compute these acre foot values at the point of diversion for a variety of irrigation systems with varying conveyance and application efficiencies (see for example the notes to Table E2). We feel the dollar per acre values of Table E1 give a good general reference for a preliminary estimate of the lease value of a given diversion in a given county where the associated land base and crop type are known. These estimates will generally always be improved by examining the site production history. Should there then be an interest in computing a value per acre foot at the point of diversion, a

meaningful estimate can only result from site level hydrological investigations.

One approach would be to measure the cumulative diverted flow at the point of diversion over the growing season and simply dividing into the total land based crop value associated with the diversion. To develop a generalized set of acre foot values we had to instead assume water use at the crop and alternative irrigation system efficiencies and work back to the point of diversion (Tables 35 to 58 below). The general values per acre foot may not be appropriate for some sites. This is because of tremendous variation across sites in the efficiency of irrigation systems - for example due to soil types in unlined ditches and the length of the ditches and their level of maintenance.

Crop-water Production Method of Water Valuation

The second valuation methodology employed was the crop-water production function method of water valuation. Estimated crop-water production functions are based on carefully conducted agricultural experiments which examine the effect of varying amounts of water inputs on the yield of a certain crop. Due to the lack of available production function studies on most of the crops of interest to DFWP, estimates of water value could be derived only for alfalfa hay. The production function approach provides the best basis for estimating value per acre/foot of water at the crop. The value per acre foot of water consumed by the plant based on Montana alfalfa hay price average for 1987-1989 is $148.63. However, to derive the value per acre foot at the point of diversion, again one needs to know the conveyance and application efficiency of the irrigation system. Taking these factors into account can lead to acre foot values ranging from $19 to $72 (Table E2).

The major use of the production function approach in this study is for validation and interpretation of the county comparison estimates. We found that the actual county level nonirrigated alfalfa yields are generally consistent with yields based on the production function relationship with SCS average rainfall as the only water input. Examination of actual irrigated yields using the production function relationship show, not surprisingly, that on average irrigated lands in Montana are not irrigated in such a way (either due to management practices, labor inputs, irrigation scheduling or water availability) as to have the full maximum (evapotranspiration) water needs of the plants met (see Tables 63-65 below). Accordingly, to derive value per acre estimates from the production function approach would require knowing the actual site specific crop water use including ground water. An alternative is to assume the crops have sufficient net irrigation to meet their maximum ET needs (as estimated by the SCS). This would overstate the value per acre due to irrigation for most counties and sites (Tables 61 and 62 below).

Table E2

Marginal Values of Irrigation Water
For Alfalfa Hay
Montana DNRC Production Functions

MPP	Crop Price	Conveyance Eff.	Field Eff.	AC/FT Value
.19	65.19	.25	.50	18.58
.19	65.19	.25	.65	24.15
.19	65.19	.50	.50	37.16
.19	65.19	.50	.65	48.31
.19	65.19	.75	.50	55.74
.19	65.19	.75	.65	72.46

Note 1: The crop Price for Alfalfa is a three year average for 1986, 1987 and 1988.

Note 2: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Note 3: The Marginal Physical Productivity (MAP) of water was derived from Montana DNRC (1989) average of four crop-water production function studies. The average function was Yield = .63 + .19 ET. ET is in inches.

Table E3 shows the scope of application in this study of the two general methods used for estimating the value of foregone production.

Table E3
Agricultural Water Valuation
Methodologies and Scope of Application

Crop	Crop-Water Production Functions	Comparison of Irr. and Nonirr. Yields
Alfalfa Hay	Yes	Yes
Wild Hay	No	Yes
Small Grains		
Barley	No	Yes
Oats	No	Yes*
Spring Wheat	No	Yes*
Winter Wheat	No	Yes*

* Asterisk denotes that care must be taken in interpreting values for certain counties as estimates are based on small acreages and may be biased.

Analysis of Actual Water Transactions

Another way to value water for leasing purposes is to look at actual transactions. It is very difficult to find water leasing transactions which are exactly comparable to the type of lease of interest to DFWP. Transactions seem to fall into three broad classes: 1) sales of water by a governmental agency from water projects such as dams or irrigation diversion projects, 2) sales or leases of water rights to municipal users and 3) sales or leases to conservation organizations for instream uses. Table E4 provides a comparison of recent water right transactions in the Western U.S.. It must be noted that while some of the transactions are temporary leases others are permanent sales of rights. These permanent sales have been amortized at a real interest rate of 4.6% in order to get the estimated annual lease value of the sale. It must also be noted that several of the transactions involve the sale of subsidized water, and thus do not reflect the full supply cost of the water. The reported water values are the values at the point of diversion and thus can be expected to be significantly lower than at the crop dollar per acre/foot water values.

The values reported in Table E4 show a range of $ 1.00 to $50.00 per acre/foot-year. These transactions all took place in 1988 and 1989. This range represents a significant refinement over

previous estimates of the range of water lease values (McKinney, 1989). This refinement is largely because we distinguish between annual lease prices and permanent transfer prices and amortize the latter into comparable annual values.

The transactions reported here do not, however, provide exact comparable sale precedents for DFWP leases because they are primarily in other states and therefore representative of possibly very different supply and demand conditions. Additionally, most transactions have not been based on displaced agricultural production but are rather from large water development projects where supply side considerations (long-run average cost of the project) dominate prices. Nevertheless, these transactions do indicate a general range of values which is consistent with the range of acre/foot values presented in this report. For example, the value per acre in Table E1 for alfalfa ranges from $51 to $125 per acre and for "other hays" average around $20 per acre. Assuming flood irrigation at 50% application efficiency and conveyance loss of 50%, and assuming actual crop net irrigation water use varying from 6" to 12" across Montana counties, the short run values per acre foot at the point of diversion could be as high as $25 to $30 /acre foot for alfalfa and around $5 /acre foot for "other hays". These values are within the range of the actual transaction prices.

The county-level comparison and production function methods of agricultural water valuation presented here have established the general range for production related values of water. These values are a good starting point for negotiating water leases, but may be the least part of the actual negotiated price. Not surprisingly there is some variation in water value across crop and county. Nonetheless, a significant finding of this study is that the plausible range of crop production-related values for Montana water is in fact fairly narrow. Additional site specific details regarding hydrology, weather and irrigation efficiency are needed in order to improve and refine the value estimates derived from these general methods in any specific case.

Table E4
Comparison of Actual Western U.S. Water Right Transactions For Purposes of Instream Flow (1988-1989)

Transaction	A/F Price	Type Of Sale	Annual Lease Value	Prime Purpose
Montana DFWP	2.00	Lease	2.00	Fisheries
Calif. Fish and Game	5.00	Lease	5.00	Fisheries
Calif. Fish and Game	5.65	Lease	5.65	Fisheries
The Nature Conservancy	2.50	Lease	2.50	Wildlife
Colorado Fishing Club	25.00	Lease	25.00	Fisheries
New Mex. Nat.Res.Dept.	15.67	Lease	15.67	Recreation
The Nature Conservancy	23.00	Permanent	1.06	Wetlands
The Nature Conservancy	33.00	Permanent	1.52	Instream
Potlatch Corporation	1.00	Lease	1.00	Pollution
Central Utah W.C.D.	50.00	Lease	50.00	Fisheries
Univ. of Colorado	7.00	Lease	7.00	Wetlands
Calif. Fish and Game	5.64	Lease	5.64	Fisheries

Analysis of the Proposed Swamp Creek Lease

We turn at this point to a brief summary of our analysis of the proposed Swamp Creek lease. This is a case of potential displaced agricultural production of the general type discussed above. (A discussion of the general case of valuing on the supply side and an application to the Big Creek site is developed below.)

We begin with a discussion of our findings based on site specific production history. The basic facts of the case, based at this point on informal discussions with Fred Hirschy and subject to further verification, are as follows:

-- Swamp Creek diversion serves approximately 600 acres

- -- Cattle graze it for 5 months (mid-May to mid-October)
- -- Current production is relatively low (approx. 10 acres per cow/calf pair
- -- If investment in an irrigation system was made the irrigated land could sustain 2 acres per pair yield
- -- If no irrigation is done production will fall to approximately 20 acres per pair
- -- Estimated amortized cost of irrigation improvements plus annual labor costs are $ 3000 per year ($4-$5 per acre)
- -- Estimated market value of land as leased pasture is $14 to $18 per AUM
- -- Hirschy water right is for 135 miner's inches or 3.375 cfs
- -- Hirschy wants the term of the lease to be at a minimum 5 and possibly 10 years.

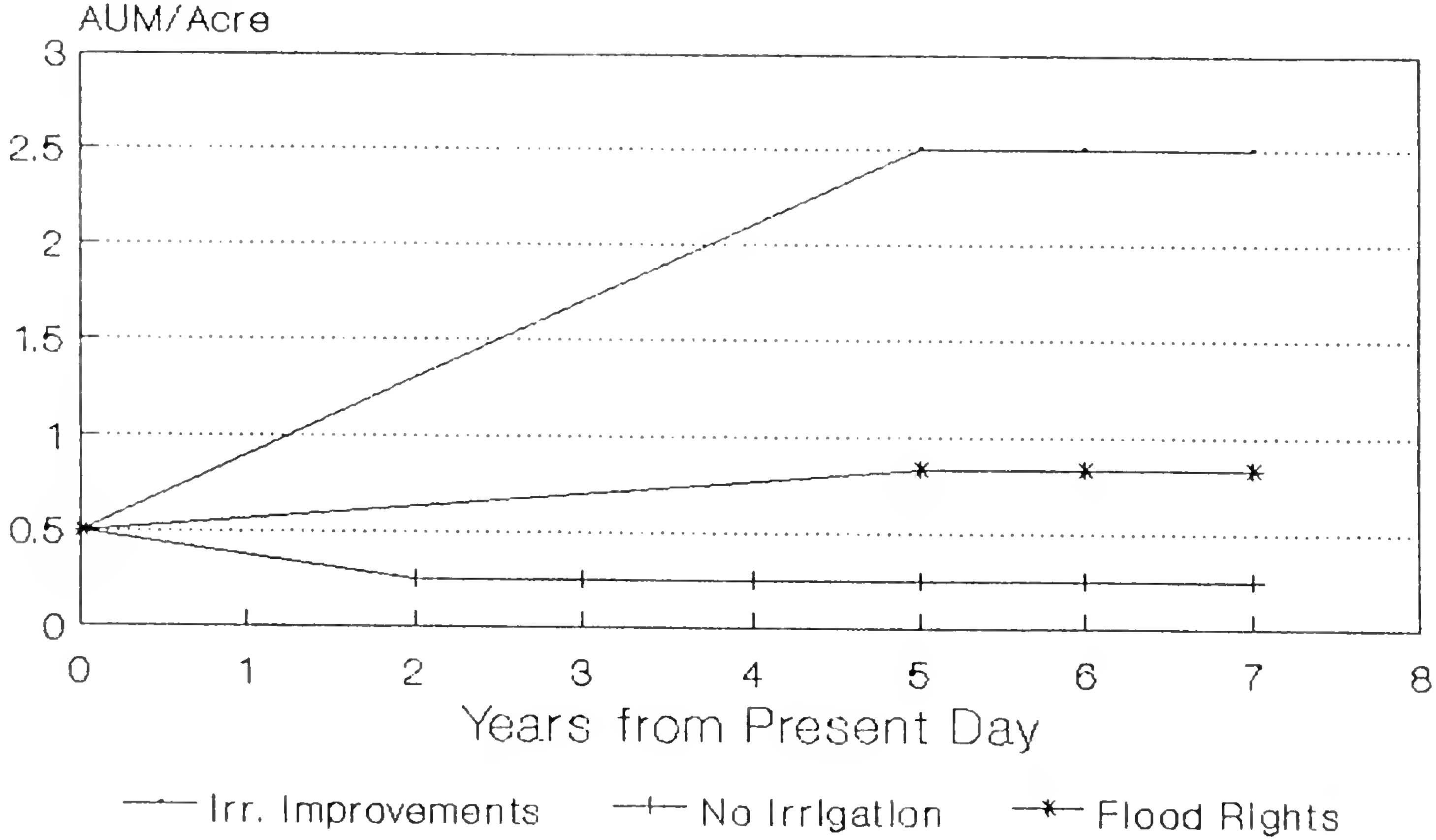
A key fact concerning the site is that the land has only been partly irrigated in recent years. Fred Hirschy is contemplating investing in the irrigation system and getting the land up to full production, which may take five years or so. We compared the no-lease situation, where grass production improves with full irrigation as in Figure 1, to two lease alternatives. The first is one where Hirschy retains "flood rights". Under this alternative Hirschy would make needed investments in the irrigation system and would irrigate using only seasonal flood rights. Under this scenario Fred Hirschy estimated that his production would be 1/3 of the production he could get under full irrigation. The second lease alternative would be for no irrigation to take place. Table E5 shows a comparison of the lump-sum and annual values of these lease alternatives for two possible lease terms, 5 year and 10 year.

The annual lease cost based on foregone production is around $8,000 per year for a five year term or $11,000 per year for a ten year term. In general, annual prices of longer term leases would be lower. The longer term lease is more per year in this case because of the special circumstances where in the first five years the field would be still coming into full production. The lump-sum and annual values derived in Table E5 are based on a real 4.6% rate of interest. Use of this parameter to compute present value lump sums implies the assumption that agricultural prices based on 1987-1989 will keep up with inflation (see discussion in Section 9).

There is some potential savings for the state in allowing the Hirschys to retain their flood rights, however, due to added costs of irrigation improvements which the landowners must bear under this option, the savings are not large. It should be noted that the key assumption in the "flood rights" option is what production is possible under flood rights irrigation. DFWP may wish to refine Fred Hirschy's estimate using site level hydrology since a change in this parameter would have a large effect on lease value.

Swamp Creek Water Lease

AUM/Acre Yield v. Time



Data Supplied by Fred Hirschy

Table E5
Summary of Costs of Alternative Swamp Creek Lease Options

	5 Year Lease	10 Year Lease
Lump-Sum Costs of Lease Options		
B. Lease with Flood Rights	$ 34,125	$ 83,081
C. Lease with No irrigation	$ 37,693	$ 93,282
Average Year-To-Year Costs of Lease Options		
B. Lease with Flood Rights	$ 7,795	$ 10,551
C. Lease with No Irrigation	$ 8,610	$ 11,847

Note: The net present value figures in the preceding two tables are calculated using a real discount rate of 4.6 %.

We also provided an estimate of the Swamp Creek lease value under the assumption that the land was already under full production. Such an analysis would be appropriate for a lease that might start 5 years from now. For this situation the general county comparison method could be applied. The county method, by the way, is implicitly for the "no irrigation" lease option given the data it is based on irrigated versus nonirrigated production. The county method also reflects the assumption that the site is currently producing the crop "other hays" (wild hay in this case) at the Beaverhead County average.

In addition to use of the county comparison method of valuation a valuation under the assumption that the land was currently producing at its potential (as estimated by Fred Hirschy) was also made for the no irrigation option. The site method is based on Fred Hirschy's estimate of likely production for this specific field. It should be noted that the site is not really hay ground, but is used for pasture. Site specific production was therefore measured and valued in terms of animal-unit-months (AUM's). Table E6 shows the comparison of these two value estimates. Note the two methods are in fairly close agreement with a total lease value of $18,402 from the county method and

$15,900 for the site method. The values per acre are $30.67 (county method) and $23.34 (site specific method). The difference of course reflects the assumptions about what level of production is possible and also the relationship of hay crop price to AUM lease price. The corresponding values per acre foot at the point of diversion are $13 to $11.

The estimates in Table E6 are representative of lease costs under the assumption that the ground is in full production. Actually, Swamp Creek is a special case where the land is not currently in full production. In fact the land has not been fully irrigated for some years and ditch improvement is underway at present. Accordingly, the value in Table E6 are for purposes of comparisons only and are not to be construed as the recommended basis for negotiating a lease in the near term.

Fred Hirschy estimates that if the irrigation system is improved, full production might be reached in five years. A site specific estimate that takes account of current actual and likely future production levels yields a total per year lease cost of approximately $7800 and $11,800 for a 5 and 10 year lease respectively. These value estimates are detailed in Section 6 below. These are the recommended values for the department to use for valuing forgone production in initial negotiations with Fred Hirschy.

Note that the estimates are based on certain parameters and assumptions developed through informal discussions. The department may wish to review these assumptions with Fred Hirschy should formal negotiations proceed, or, better yet, provide Fred with a copy of this report for his review. It may be that the Swamp Creek case is one where the most advantageous arrangement for both sides might be one of providing Hirschy with flood rights. This is a variant of the stand-by or hybrid lease with provisions for lessor's use of water as described in Section 8.

Table E6
Comparison of County and Site Specific Value Estimates
Swamp Creek Lease Under Assumption of
Full Production (600 Acres)

	County Method	Site Method (5 Year Delayed Lease)
Water Value per Acre	$ 30.67	$ 26.50
Total per year lease cost	$ 18,402	$ 15,900
Acre/Foot Value (1417.5 ac/ft total)	$ 12.98	$ 11.22

<u>Valuation Based on the Cost of Supply</u>

The second case we examine is where the value of water in a given market is dominated by the costs of an increment in the quantity of water supplied. This is typical in an area where most water is made available through a basin-wide reservoir and irrigation project. Here water is priced (aside from subsidies) to cover the costs of the investment and operation of the system. An example of a transaction in this type of situation in Montana is DFWP's purchase of water from Painted Rocks Reservoir in the Bitterroot Valley. This situation would also typify cases where other types of investment, for example in improved irrigation system efficiency, would also in effect increase the supply of water potentially available for instream flows. The price will of course also depend on market structure.

<u>Analysis of the Proposed Big Creek Lease</u>

As described in detail in Section 7, Big Creek is a site where irrigators are considering replacing a very inefficient ditch system with a buried pipeline. The improvement in overall efficiency (from perhaps as low as 12% at present) is likely to be such that a good quantity of water could remain in the creek. At present the creek bed is entirely dry for several months a year below the point of diversion. The analysis of the potential value of salvaged water on Big Creek presented several challenges. First, since the lease would not result in any displaced agricultural production, as in the case of Swamp Creek, neither of the two general methods used to value displaced production could rightly be applied. Rather it was determined that the value of the salvaged water should be based more on the costs of supplying that water; the costs of the pipeline. As we detail below, we considered three different methods for

estimating this supply cost-based water value. Because of a lack of complete knowledge of project costs and benefits (as detailed in Section 7 below) two could not be undertaken. All three rest on different principles concerning what is a "fair" way to share the costs of the Big Creek project between DFWP and the irrigators. Note that from the theory of the firm perspective, this is an example of the general problem of allocating joint costs among several qualitatively different outputs - a problem which has no general solution in microeconomic theory.

A valuation method which was applied allocates pipeline construction costs between agricultural water users and instream benefactors based on the proportion of water each uses. This is one possible outcome of negotiations and is based on a "fairness" principle that costs be shared based on relative use. Note that project costs are based on very preliminary estimates from Park County SCS - with a large range of from $210,000 to $350,000. Additionally, these costs exclude the costs of sprinklers and other movable irrigation capital investment that ranchers will need to make. A point for negotiation is whether these costs should also be shared. These SCS estimated costs may also be reduced depending on SCS cost sharing; the extent of this cost sharing is also uncertain. For purposes of this analysis we assume cost sharing of zero. Table E7 shows the results of this analysis.

Based on the "fairness " principle wherein each water user shares in the total costs based on the expected amount of water they use (see Section 7). DFWP's share of total costs would be 43%. This is based on an estimated 20 cfs taken by the pipeline for the mid-June through September period, which would leave 15 cfs in the creek below the diversion. Accordingly, 43% of the 210,000 to 350,000 project cost is $90,300 to $150,500. These would be possible lump-sum lease cost estimates for initial negotiations. Another way to compute water share (an issue for negotiation) might be to look at the full irrigation season as the time basis for the irrigator's use and include DFWP's water use as the sum of negative differences between actual daily average flows at present and the desired instream flow level (15 cfs?) also over the irrigation season. Site specific hydrological investigations would be needed to evaluate this approach.

To compute the per year costs of the lease, an agreement needs to be reached on the appropriate term and discount rate. For example, with a 20 year term based on project life and a real 4.6% discount rate, the per year cost is $6973 to $11,653. It is interesting to note that the associated per acre foot values ($2 to $4) estimated with those parameters are within the range of other supply cost based transactions observed in the West (eg. Painted Rocks water sold at $2.00 acre/foot, Snake River Water Bank water sold at $2.50 acre/foot).

Table E7
Big Creek Supply Cost Based Water Values
Costs Shared on the Basis of Amount of Water Used

	Discounting Option 20 Year 4.6%
Total Project Cost	210,239 -- 350,402
Annual Amortized Cost	16,303 -- 27,171
Total Acres Involved	1177
Cost / Acre / Year	13.85 -- 23.08
Total Acre/Feet June 15 - Sept 30	7428.2
Average Acre/Foot Value	2.19 -- 3.66
Implied "Fair" Cost Share to DFWP	$ 6,973 -- $ 11,653

Pending site specific hydrological investigations and more complete project engineering and evaluation of potential net returns to the irrigators, it is difficult at this point to further refine these estimates.

Should further information become available, DFWP may wish to examine the other possible approaches described below in Section 7. For example, another way to look at the problem is to compute the DFWP cost share necessary to make the project feasible for the irrigators. (Or alternatively, to reduce their risks sufficiently that the project actually can proceed.) Sufficient information is not available to examine the case from this standpoint at present.

Drafting Leases for Instream Flow

Section 8 below details concerns, provisions and possible alternative lease forms identified by Josephson and Fredricks. In general, however, the diverse nature of Montana agricultural land and water rights appurtenant to it dictate that leases be drafted on a case by case basis. Despite the legislative mandate for

DFWP to develop a complete model lease, attempting to develop a generic "model" lease may prove an inefficient use of time and resources given the high fact-dependent nature of these leases. It is advised that DFWP rely on a model form only as a starting point and take care to design the lease to the specific demands of the individual situations.

Recommendations

The average county and crop level values per acre associated with irrigation developed below should provide a good reference point for estimating lease values. The same can be said for market transactions evidence from other regions. Somewhat surprisingly, the range of values we have identified is not extremely large. Nonetheless, there is considerable variation from farm to farm in what irrigation water is worth to a specific operation. Factors such as availability of groundwater, on-farm processing of crops, crop rotation practices, soil fertility, and existing investments can all affect the production value of water.

Given this site-specificness of the problem, agencies wanting to lease water should anticipate the need to examine the facts of each situation individually.

Another general observation is that the interplay of lease options and economics is fairly complex (see Section 9). For every lease element, from term to water amount and timing, there is another permutation of lease price. A recommendation that comes out of our discussions with Ernie Harvey and others is that the agency should consider having someone (or several people) familiar with both the law and agriculture do the actual lease negotiation. The impression of the economists involved in this project is that Richard Josephson, who is sensitive to the concerns of farmers and ranchers but also knows the law, would be a good candidate.

Specific recommendations by Josephson and Fredricks regarding lease structures and changes in Montana law are detailed in Section 8.

1. INTRODUCTION

This report provides estimates of market values for leasing agricultural water in selected Montana counties for instream flow purposes. Additionally, Section 8 by Mark and Richard Josephson examines the legal elements of lease agreements.

Objectives

The objective of this project was defined by three specific tasks. Tasks I and II involve estimating the value of water in agricultural use while task III involved structuring lease agreements. The general scope and approach to the valuation tasks is as follows.

Task I: The objective of Task I was to estimate the range and average price for leasing water that is currently used to irrigate alfalfa, wild hay and small grains using a variety of irrigation technologies and for eight Montana counties: Beaverhead, Broadwater, Deer Lodge, Jefferson, Lewis and Clark, Meagher, Park and Ravalli. The general approach suggested by Montana Department of Fish, Wildlife and Parks (DFWP) in their request for proposals was: review the practice and experience in water leasing for instream flow in other states (Task I.A.), then propose methods based on this review (I.B.), and finally apply the method to selected Montana crops and locations. This general sequence was followed in this study.

Task II: The objective of Task II was to estimate the value of water for two specific streams: Big Creek and Swamp Creek. The sequence of this task was to first collect site specific information (Task II.A.), apply the approved methods (II.B.) and document the work (II.C.).

General Methods

Our general approach to these tasks was to first review the agricultural economics literature on irrigation water valuation and consult with local and state agencies involved in these issues. This literature review is summarized in Section 2 below. After consultation with DFWP, we also began a review of Water Market Update to identify recent instream flow lease transactions. Further information on these transactions was gathered by contacting the parties involved. This review of actual market transactions is summarized in Section 3.

The most defensible way to estimate a fair market value for irrigated water is to look at actual transactions in comparable situations. Not surprisingly our review of actual transactions did not identify situations that are sufficiently comparable to the case at hand. The alternative is to examine the nature and

extent of the potential market for irrigation water in the given case. Our discussion here is limited to market prices that are derived from agricultural use of water. It is beyond the scope of this analysis to consider the effect on price of the recreational value of water used to augment instream flows. Depending on the situation, the prices or values computed below may be considered minimum estimates of possible transaction prices where the potential upper limit to possible transaction prices is the (unquantified) recreational/fishery value.

The fair market price will of course be a function of both supply and demand. There seem to be at least two general cases in Montana with regard to the market situation. In one case, the price of water in a given area may be dominated by the supply of water made available through a reservoir or other major public water investment. Given fairly elastic supply throughout the range of possible demand, price will be dominated by the costs of the investment. For example, amortized investment costs are the primary basis for prices actually paid for water from Painted Rocks Reservoir in the Bitterroot.

Another common type of situation is one where supply in the short run is essentially fixed and price is dominated by demand-side factors. A typical case is one where the market is very limited spatially (due to water transport costs and legal setting) and the only potential alternative use is irrigation on a well-defined (and limited) land base. In this case the value of water is largely tied to the value of the irrigated agriculture that would be displaced.

For the situation where price is dominated by the demand side, there are two basic approaches that economists use to value irrigation water: crop-water production functions and farm budget analyses. In order to provide a sound overview of the problem, we chose to implement both methods. The crop-water production function follows directly from basic microeconomic theory. Since water is an input to agricultural production, the value of water is its contribution to production (marginal product) times the price of the crop. The farm budget analysis approach was implemented in two ways: using county-level historical production data for specific crops on both irrigated and nonirrigated soils and by examining the production history at the specific Swamp Creek and Big Creek sites. The limitations of each method, key assumptions and computational details are summarized in Section 4.

To conclude this summary of general methods, in the absence of directly comparable transactions, it is necessary to first characterize the market for the specific water that may be leased. Two common situations are one where the market is dominated by supply (due to investment in water development) or one where it is dominated by demand-side considerations (the

value of displaced agricultural production). In any application to a specific stream it is first necessary to determine the general extent and type of market. For example, it may be in some situations that demand for a given stream is dominated by a non-agricultural use, such as municipal water. This is the basis for water market transactions at upwards of $1000/acre-foot in the Southwest U.S. However, for the problem at hand, we have limited ourselves to water values based on the demand derived from irrigated agriculture.

Scope of the Estimates

Estimated irrigation water values for the crops and counties listed in Task 1 are described in Section 5. These estimates are based on our two general methods for valuing displaced agricultural production: the production function approach and county-level historical comparisons. As detailed below, the production function approach was applied only for alfalfa (due to the limited studies available that utilize this approach). The county-level comparison was done for all the crops and counties listed above.

Section 6 and Section 7 summarize the site specific estimates of the value of leased water in Swamp Creek and Big Creek respectively. The value estimates in Swamp Creek are derived using the county level general method for valuing irrigation water and actual production history in that drainage. Big Creek, by contrast, is a case where the potential supply of water will be augmented by investment in a more efficient irrigation system. This water is best valued on the supply side - at the cost of the investment in the irrigation system as described in Section 7.

2. LITERATURE REVIEW OF AGRICULTURAL WATER VALUATION

Difficulties Inherent in Water Valuation

Economic theory would suggest that the best method for estimating the value of water in irrigated agriculture would be to observe the prices paid by farmers for that water. Such observations would allow the construction of a demand schedule based on quantities of water used at various price levels. However, according to Colby (1989), the prices that farmers pay for water do not vary significantly within regions and it is therefore not possible to estimate this type of water demand function (Colby, 1989). Rather, more indirect estimation methods are often used to determine the agricultural value of water. These alternative methods, which include farm budget analysis and crop-water production functions, present challenges which direct observation of market activity does not. These limitations and difficulties as outlined by Young and Gray (1972) are discussed below.

(1) Difficulties in getting a consistent measure of productivity from water inputs

A) Agricultural production is a highly complex and variable endeavor. Unlike laboratory experiments, studies of crop yield-water input relationships vary from one study to the next. This is true because factors such as plant disease, pests, climactic conditions and differences in managerial skills cause crop production from constant water inputs to be highly variable. It is neither practical nor possible to control for all of these variables across studies.

B) Crop yield response to water inputs is very sensitive to how that water is combined with other inputs. The combination of water and fertilizer is perhaps the most important combination of inputs to the growing process, and the relative proportions of these two inputs can have dramatic effects on crop yield. Combinations of water with capital investments in water distribution equipment are also important in determining irrigation water productivity.

C) A consistent measure of productivity from water inputs is difficult also because there are many possible crops which can be grown and many varieties of each of these crops all varying somewhat in input requirements and yield.

D) A further complication is that all water inputs are not equal. Crop response is inhibited by salinity, if any, in the water.

E) A final complication which adds to the difficulty of getting a consistent measure of crop-water productivity arises from the fact that productivity of water tends to vary widely over the year. The productivity of water increases as the length of time since the last moistening increases. Additionally, water productivity varies over the life cycle of a plant. Indeed, water application near harvest time might add little to the yield of a crop or might even decrease the quality of the existing yield.

(2) Difficulties in measuring water inputs

There is a basic difference between the amount of water diverted onto a farmers land and the amount which is made available to the root zone of the plants for use. This difference arises because there are two types of loss which occur before the water reaches the plants. The first is conveyance loss which arise through seepage from unlined or poorly lined ditches and evaporation loss from the same. This type of loss can be substantial with poor conveyance systems losing 50% or more of available water before reaching the application system (USDA Soil Conservation Service). The second type of loss is application loss from evaporation and

runoff. The efficiency of application systems range from approximately 50% for graded furrow application to 65% for center pivot and sidewheel sprinkler applications (Montana DNRC). The result of these two sources of irrigation inefficiency is that the value per unit of water used in agriculture is much lower when measured at the point of diversion than when measured as evapotranspiration losses from the field.

(3) Unrealistic pricing of inputs and outputs

It is often difficult to determine the true value of water to agriculture because neither all inputs nor all outputs of the production process are accurately priced. On the output side agricultural prices are often held artificially high by government price supports. These artificial prices tend to inflate the value of water as applied to agriculture. Many inputs to agriculture are not priced fully and thus also inflate the calculated value of water. These inputs are such factors as managerial skills, specialized knowledge and return to risk bearing. Returns to management skills can account for 25 to 33 percent of the value typically assigned to water inputs (Young and Gray, 1972).

(4) Length-of-run of water valuation study has an effect on the value of water.

The more inputs to the productive process that are considered variable, the lower the marginal value of water as an input will be. This means that the short-run value of water will be larger than the long run value of the same water.

Both crop-water production function estimates and farm budget study estimates are complicated by these difficulties; production functions by the first two and budget studies by the last two. While it is possible to control or correct for some of these complications water value estimates derived from these methods must still be cautiously applied to other sites and other methods of production.

There are basically three methods for determining the value of irrigation water in the absence of functioning water markets. These are: comparisons of yields from irrigated and non-irrigated acreage, farm budget analysis (including linear programming) and crop-water production functions.

<u>Comparisons of Yields from Irrigated and Nonirrigated Lands</u>

When irrigated and dryland production of a crop occur within a homogeneous farming area and factors such as soil type and weather are similar, differences in net profits can be attributed to irrigation (Gibbons, 1986). In practice this methodology is not often used but it provides a fairly straightforward

methodology for calculating water values and was the preferred method of the United States Water Resources Council (Gibbons p.29). The difficulty in applying this method is in finding farms in the same areas, with similar soils, growing the same crops in a dryland and irrigated manner.

Farm Crop Budget Analysis Estimates

The comparison of irrigated to dryland production is a special case of a more general water valuation methodology known as farm crop budget analysis. This type of analysis estimates the maximum revenue share of water as an input to crop production. Total crop revenue minus all non-water input costs leaves a residual amount equal to the maximum amount a farmer would be willing to pay for water and still cover the costs of production. This residual therefore represents the on-site value of water. This amount can be divided by the total number of acre feet of water used in the production process to determine the willingness to pay per acre foot for the water. This willingness to pay can be either a short run or a long run value, depending on whether or not fixed costs of production are included in the analysis (Gibbons, 1986).

Farm crop budget analysis generally calculate on-site values for water. These on-site values are not directly comparable to instream flow values because the costs of acquiring the water and transporting it to the field are not accounted for. If these costs are considered the resulting net value of water is comparable to instream or other "at the source" values. An example of the difference between on-site and net values of water was shown by Lacewell, Sprott and Beattie (1974). Their farm crop budget study found that the on-site value of water in wheat production was $27.00 per acre foot while the net value was only $15.00 per acre foot.

Table 1 shows a comparison of farm crop budget analyses for alfalfa, wheat, and barley. The acre foot value estimates are short run, on-site estimates unless otherwise noted.

Table 1 shows significant variation in the water values associated with alfalfa, wheat and barley across studies. This is understandable given the variability in productivity of farmland across the west, and the differing methodologies across the studies.

Crop-Water Production Function Estimates

Crop-water production function estimates are not dependent on economics of crop production and thus are not related to costs of production, either fixed or variable. Rather, these marginal values are related only to the selling price of the crop and the physical productivity of the water unit (Gibbons, 1986). The

relationship between inputs and outputs in the crop production process can be expressed as a mathematical production function. When all other inputs are held constant the marginal value of an acre foot of water can be calculated as the marginal physical product times the crop price. Table 2 shows crop-water production function estimates of acre foot water values from U.S.D.A. controlled experiments in Arizona, New Mexico, Colorado, Texas, Idaho and Washington. The values for wheat and alfalfa are shown.

Table 1: Farm Crop Budget Analysis Water Value Estimates for Alfalfa, Wheat and Barley.

	Value Estimates (per Acre Foot)		
Study	Alfalfa	Wheat	Barley
Lacewell et al. (1974)	--	15[1]	--
Willitt et al. (1975)	20[2]	18[2]	5[2]
Lacewell et al. (1975)	--	8[1]	--
Kelso et al. (1973)	25-41	30-32	27-35
Martin et al. (1979)	24	40	32
Shumway (1973)	26[2]	--	22[2]
Washington State U. (1972)	10	52	--

Note: All values are indexed to 1980 crop prices. Dashes denote missing values.

[1] Values are net water values.

[2] Values are long run values.

Source: D.C. Gibbons, "The Economic Value of Water", Resources for the Future, (1986), Washington D.C.

Table 2: Crop-Water Production Function Estimates of Water Value for Alfalfa and Wheat.

State	Value (per Acre Foot) Alfalfa	Wheat
Washington		
Ayer et al. (1983)	--	59
Arizona		
Ayer and Hoyt (1981)	25	22
New Mexico		
Hoyt (1982)	25	--
Texas		
Hoyt (1982)	--	35

Note: All values are indexed to 1980 crop prices and reflect on-site values.
Source: D.C. Gibbons, "The Economic Value of Water", Resources for the Future, (1986), Washington D.C.

3. REVIEW OF WATER LEASING MARKET TRANSACTIONS

While farm crop budget studies and crop-water production functions can provide theoretical values for water used in agricultural production, these values only address one side of the water transaction equation. For many situations, the theoretical values cited in the previous section represent the maximum amount a farmer would be willing to pay for the water and hence are probably overstatements of the true market driven prices which would exist for water for agricultural uses. Such prices would be determined by the interplay of supply and demand forces. However, it should be noted that what a farmer is willing to pay will also depend on the economics of the specific operation. For example, some operations may be vertically integrated with crops grown for feeding on-farm stock. In this case, the crop value may actually understate the value in the operation. Additionally, some crops are grown in rotation with payoffs to legumes, for example, based in terms of multi-year affects on other crop production.

It is interesting to examine recent water transactions in order to compare prevailing water prices in the western U.S. to the theoretical values. This section provides a discussion of the types of and extent of water market activity in the West, as well as examples of market determined water values.

Their are two types of water rights which are sold in western water markets: the right to a certain quantity of water in a year (usually referred to as water leasing) and the right to a flow of water each year into the indefinite future. The value of the second type of water right (permanent right) is equal to the discounted present value of the stream of annual values. This discounted present value is affected by the time horizon, the interest rate and expectations of inflation (Young, 1984). The capitalized value is normally 12 to 20 times the annual value. This implies a discount rate of between approximately 5% and 8%.

Permanent Sales of Consumptive Water Rights

The prices of these water rights tend to be determined by long-run expected supply and demand within a certain spatial market. Short-run water supply conditions seem to effect the market prices paid for these permanent rights only to the extent that the short-run conditions are viewed as likely to be permanent.

Examples:

(i) Colorado-Big Thompson Project (CBT)

Permanent shares (each for .7 af/yr) sell for a relatively stable price (1989 approximately $1500 af) [Water Market Update (WMU), Dec. 1989]

(ii) Reno Nevada Area

Water right prices around Reno have stabilized in the 2000 to 3000 dollars per acre foot range. [WMU, Dec. 1989]

(iii)City of Albuquerque has a standing offer to buy rights for $1000 af. Transactions at this price continue to occur. [WMU, Dec. 1989]

(iv) Denver, Colorado

Prices for water rights are currently rising, and are approaching $5000 af. [WMU, Dec. 1989]

Temporary Leasing of Water Rights

Temporary leasing of water rights is generally designed as a short term hedge against drought effects or water shortages. The prices paid for these short term leases are highly sensitive to expectations about the short term supply of water.

Examples:

(i) Yuba County (CA) Water Agency (YCWA)

In 1989 YCWA in anticipation of drought conditions later in the year sold water to several entities at $45 af. Later in the year, when rains eased drought conditions the prices of these leases dropped to $11 af.

(ii) East Bay Municipal Utility District (CA) (EBMUD) was the second largest buyer of YCWA water at the $45 price . When rains eased the drought conditions later in the year EBMUD sold 30,000 af of the original 60,000 which they purchased to the California State Water Resources Control Board to enhance salmon migration and wetland habitat. The reselling price was $5 af. [WMU, Oct, 1989]

(iii)(EBMUD) attempted a hedge against future drought by offering a long term contract to purchase water from local irrigators for $50 af in those years deemed critically dry by the state. In a letter to EBMUD the manager of the local irrigation district said the district had no water to sell at <u>any price</u> since all supplies appeared to be needed by local irrigators.

In some areas the price of temporary transfers of water is set by a "water bank" or a governmental entity and transfers occur on an ongoing basis between those with surpluses and those needing more.

<u>Examples</u>:

(i) East Columbia Basin Water Bank.

In 1989 3 irrigators leased 1000 af for between $10 and $12 af from neighboring irrigators with surpluses. [WMU, Oct. 1989]

(ii) Upper Snake Water Bank.

In 1989 over 100,000 af were traded between irrigators and Idaho Power Company for $2.50 af.

<u>Comparable Instream Flow Water Leases</u>

The following list of transactions provides a review of water purchases in the western U.S. which were made for the purpose of enhancing streamflows to benefit fish or wildlife. The details of the transactions were obtained from Water Market Update (WMU).

<u>1987 Montana DFWP</u>

The Montana DFWP spent $20,000 to lease 10,000 acre feet of water from Painted Rocks Reservoir to augment the low flows in the Bitterroot River. [WMU, Aug. 1987]

Acre-Foot Value <u>$2.00</u>

<u>1989 California F and G</u>

The California Fish and Game bought 30,000 af from EBMUD to support fish and wildlife habitat.
[WMU, Oct. 1989]

Acre-Foot Value <u>$5.00</u>

<u>1989 California F and G</u>

The California Fish and Game bought 45,000 af from the Bureau of Reclamations Central Valley Project to improve stream flows for Chinook Salmon and improve wetlands.

[WMU, Nov. 1989]

Acre-Foot Value $5.65

1989 The Nature Conservancy

The Nature Conservancy and other supporters purchased 3200 af of water from the Upper Snake Water Bank for $8000 to aid starving Trumpeter Swans.
[WMU, Mar. 1989]

Acre-Foot Value $2.50

1989 Colorado Fishing Club

A Colorado fishing club is leasing 18 af of water for $450 to augment evaporative losses from their fishing ponds.
[WMU, May 1989]

Acre-Foot Value $25.00

1984 New Mexico Natural Resources Department

The Natural Resources Department paid the city of Albuquerque 2.35 million dollars to lease 6000 af/year for 25 years. The water is used to maintain a recreational reservoir and augment weekend rafting flows in the Rio Chama.
[WMU, June, 1989]

Acre-Foot Value $15.67

1989 The Nature Conservancy

The Nature Conservancy closed a net purchase of 74 acres of wetlands and 6 cfs water right from Formation Spring for "ecological purposes". This was a permanent transfer of water rights and not a short term lease.
[WMU, April, 1989]

Acre-Foot Value $23.00 permanent

1988 The Nature Conservancy

The Chevron Corporation donated 200,000 af of water, at an estimated value of $7.2 million to the Nature Conservancy to maintain instream flows on the Gunnison River.
[WMU, APR. 1988]

Acre-Foot Value $33 permanent

1988 Potlatch Corporation

The Potlatch Corporation purchased 30,000 af from upstream reservoirs to dilute its effluent.
[WMU, Oct. 1988]

Acre-Foot Value $1.00

1988 Central Utah Water Conservancy District

the CUWCD purchased 9500 af from a number of private and local governmental sellers to augment low winter flows in the Provo river. [WMU, Dec.1988]

Acre-Foot Value $50.00

1988 University of Colorado

The U of C purchased 12.5 af from the city of Boulder to offset evaporative losses in recently constructed wetlands replacement ponds.
[WMU, Dec. 1988]

Acre-Foot Value $7.00

1988 California Dept. of Fish and Game

The California F and G purchased 45,000 af from the Bureau of Reclamation's New Melones water into the Stanislas River. The release will facilitate Salmon Migration and later will be diverted into wetlands.
[WMU, Nov. 1988]

Acre-Foot Value $5.64

1988 Colorado Department of Natural Resources

Attempting to purchase 750,000 af of Yampa river water rights to protect endangered fish for $6 million.
[WMU, Oct. 1988]

Acre-Foot Value $8.00 Pending

4. METHODS FOR VALUING AGRICULTURAL WATER IN MONTANA

Introduction

In the absence of comparable sales for establishing fair market price, it is necessary to use alternative methods for estimating the value of leased water. As noted previously, the value of water depends on both supply and demand factors. For purposes of this report, we examine two possible cases. These cases will be defined by the spatial extent of the market and the changes being considered to make instream flows available.

Case A is where the potential alternative uses of a given water right are limited to irrigated agriculture. The market is spatially limited and it is possible to identify the likely land base for this agriculture. In this case the value of the water is a function of the size and quality of the irrigable land and on the climate, feasible crops, and application of other inputs (capital investment in the irrigation system, type of system, fertilizer, labor input, management and irrigation scheduling, etc.). Feasible methods for valuing agricultural production that would be displaced by instream flows include crop-water production functions, county level historical production history, and site specific production history. The latter two approaches are variants of a farm or enterprise budget approach.

Another plausible situation, Case B, is where the value of water in a given market is dominated by the costs of an increment in the quantity of water supplied. This is typical in an area where most water is made available through a basin-wide reservoir and irrigation project. Here water is priced (aside from subsidies) to cover the costs of the investment and operation of the system. This situation would also typify cases where other types of investment, for example in improved irrigation system efficiency, would also in effect increase the supply of water potentially available for instream flows. The price will of course also depend on market structure.

These two simple cases abstract from a larger set of possible determinants of fair market price. For example, in certain locations prices may be dominated by the demand for municipal water, industrial uses, hydroelectric use, private recreational uses or augmented flows to improve water quality (dilution of pollution concentrations). Our focus is limited to the Case A and B situations described above which are thought to be most relevant for future leasing of instream flows in Montana.

The two cases and specific methods we investigated are summarized in Table 3. Each case and specific method will be discussed in turn.

Table 3

Alternative Valuation Methods for Leased Water for Instream Flows

<u>ALL CASES WHERE AVAILABLE</u>

Market transactions evidence for comparable sales.

<u>CASE A: DISPLACED AGRICULTURAL PRODUCTION</u>

Method 1. Production Function Approach.

Method 2. Aggregate County-level Production History on Irrigated and Nonirrigated lands.

Method 3. Site Specific Production History.

<u>CASE B: INCREASED SUPPLY THROUGH WATER DEVELOPMENT INVESTMENT</u>

Method 4. Estimate costs (supply price).

Methods for Estimating the Value of Water in Irrigation Use

Where instream flows will be made available by foregoing agricultural production, the value of the water is dependent on: a. the land base (acres), b. the crop type, c. the market price for the crop, d. the level and costs of other inputs (labor, management, capital investment, type of system), and e. the contribution of water to production.

Methods 1 to 3 generally make use of the same information on items a to d, but differ in how the effect of water on crop yields is determined. Method 1, the production function approach, is generally based on agricultural experiment station controlled experiments where the amount of water is systematically varied for a given crop. The assumptions necessary for applying this approach to a Montana site are: 1) soils and other environmental conditions are similar between the experiment and the Montana site and 2) other inputs (fertilizer, labor, etc.) are at similar levels.

Method 2 and 3 estimate the effect of water on yields by looking at actual production history on the sites of interest. Method 2 uses aggregate county level production records on irrigated and nonirrigated soils. Method 3 examines the production history for the specific site. The key assumption of Method 2 is that irrigated and nonirrigated lands in a given county are equally productive. This probably overstates the water value given that the better soils are more likely to be irrigated. The problem with Method 3 is that production history may not be available for the site in a with-and-without irrigation state or that the history is short and is difficult to interpret given climatic cycles. In order to derive values per acre foot of water, both methods 2 and 3 require a further assumption of the amount of water the irrigated sites received during the production history. For method 3 this may require on-site hydrological investigations. For either method an alternative is to assume that the crops received the necessary "net irrigation" computed by the Soil Conservation Service for the given county, taking into account maximum potential evapotranspiration and rainfall. Additionally, methods 2 and 3 require cost data. All three methods require price information.

As we describe below, all three methods can be used to compute both a value per unit of water (acre-foot or cfs over a given period) or a total value for a given land base (under the assumption of available "net irrigation"). The latter (total) value would seem to be the most useful estimate for purposes of lease negotiation as it is a preliminary estimate of a plausible lease price for a given right. Additionally it is necessarily tied to the factual situation that actually determines the value of a given right or diversion: the land base and the production made possible on that base by irrigation including short and long

term production and possibly the use that production has in the overall farm operation.

Where the production difference due to irrigation can be observed, the total net value associated with irrigation of a given land base and crop type can be fairly easily estimated, however, we would note that the value per acre-foot must be carefully defined. For example, suppose that the net crop value of a given irrigation diversion is estimated to be to be $1000 per year. If 100 acre-feet are diverted over the season, this implies a value of $10/AF. However, if conveyance loss (in the irrigation ditch) is 50 percent and application efficiency is, say, 50 percent also only 25 acre-feet are available to the plant root zone. Thus the value per acre-foot at the crop is $40. Accordingly, care must be exercised in the use of acre-foot values.

This point is noted because the production function approach begins with an acre-foot value <u>at the crop</u> and can be used to derive a total value for a given diversion. Conversely, the production history (or farm enterprise budget) approaches begin with a total value computation based on the acreage and crop. An assumption (or hydrological measurement) about water used is necessary to convert this to an acre-foot value at the crop. Additional assumptions about conveyance and application efficiency (or hydrological measurement) may be necessary to convert this to an acre-foot value at the diversion point. The computations necessary for each approach are detailed below.

Method 1. Production Function

The production function approach is based on the microeconomic profit-maximizing model of the firm. A basic result of this model, which is available in any basic economics text, is that the business firm will be willing to pay a price for inputs equal to the contribution of that input to production (marginal product) times the value of the output or:

$$Wj,c,s = MPPj * Pj \quad (1)$$

where, for the case at hand:
Wj,c,s = the short run value of water per acre foot at the crop for crop j.
$MPPj$ = marginal physical product for crop j (from the economics literature)
Pj = crop price, based on Montana historical price series.

Then, given net irrigation per acre for the given crop by county (Nij) and total acres for the given crop (Aj), total short run value is given by:

$$Tj,s = Wj,c,s * Nij * Aj \quad (2)$$

The value is "short run" in that an assumption of the model is that the change in production is given ceterus paribus (all other inputs are fixed at some given level). Accordingly, this is a short run since at least some inputs (such as investment in the irrigation system, the amount of land, etc.) are fixed. The key assumption of the model is that Nij is equal to the maximum net irrigation as identified by the SCS for that crop and county - in other words that sufficient water is available to the plant to achieve maximum potential evapotranspiration for the site. This may not be an appropriate assumption for a given case (due to limits on amount or timing of water availability or the limits of a given type of system in particular soils (flood irrigation in gravelly or sandy soils). Accordingly, it may be necessary to modify Nij to some ratio of Nij based on site hydrology investigations or simple computations based on the diversion and efficiency of irrigation conveyance and application systems.

A short run value per acre-foot can also be computed at the diversion point given overall system efficiency (conveyance times application efficiency or "Ek" where there are k permutations of conveyance systems (unlined ditch, lined ditch, pipeline, etc) and application systems (flood, center-pivot sprinkler, etc.)) or:

$$W_{j,d,s} = W_{j,c,s} * E_k \qquad (3)$$

A detailed application of this method to Montana counties and crops is provided in Section 5. The fact that the production function approach yields a short run value raises the issue of when short run values are appropriate to use. The short run - long run distinction would apply to the type of lease, but not necessarily the length of the lease. A grower with a lease that specified a call on water in dry years would be in the short run situation just as much as one with a one year lease. With a fairly thick market in second hand irrigation equipment, the crucial factor putting a producer in the long run situation would be the fact that the lease was for water every year, not that its term was 10 years instead of 5.

Method 2. County Production History

The analytical basis for Method 2 is the observed difference between irrigated and nonirrigated lands for a given crop and a given county or Qij, with units of tons, bushels or AUM's per acre-year. This method begins with an estimate of total net value to irrigation water on a given land base Aj (acres) or:

$$T_{j,s} = Q_{ij} * R_{j,s} * A_j \qquad (4)$$

where Rj,s is the net income per unit of production (eg. per ton of alfalfa, etc.) in the short run or Pj minus average variable

costs (labor, management, power for pumping, etc.). Alternatively, this approach can also be used to compute a long run total value, $T_{j,l}$ or:

$$T_{j,l} = Q_{ij} * R_{j,l} * A_j \quad (5)$$

where $R_{j,l}$ is price, P_j, minus total average costs (including the costs of the irrigation system) for the enterprise. $T_{j,l}$ will be lower than $T_{j,s}$ because it factors in the costs associated with investing in the irrigation system. In the short run a rancher will need to be compensated for the difference between price and variable costs (labor, power, etc.) because he is stuck with the costs of his investment. In a long run situation, where the rancher has not yet made the investment or would need to reinvest over the term of the lease in his system, the net return he would actually forego is lower - because it includes the cost of his investment. This is an analytical reason for expecting lower per year lease costs for longer term leases.

The net foregone value associated with not irrigating a given land base can also be used to compute the values per acre at the crop ($W_{c,.}$) and at the point of diversion ($W_{d,.}$). The definition of these is the same as for the production function approach, except that both long and short-run values can be computed:

$$W_{c,j,s} = T_{j,s}/(N_{ij} * A_j) = (Q_{ij} * R_{s,j})/N_{ij} \quad (6)$$

$$W_{c,j,l} = T_{j,l}/(N_{ij} * A_j) = (Q_{ij} * R_{l,j})/N_{ij} \quad (7)$$

$$W_{d,j,s} = W_{c,j,s} * E_k \quad (8)$$

$$W_{d,j,l} = W_{c,j,l} * E_k \quad (9)$$

where variables are as previously defined.

For the Case A situation, it may be noted that the market transactions reported in the preceding section would be most comparable to the diversion water price ($W_{d,.}$) shown here. The equations indicate that these prices are directly proportional to conveyance and application efficiency and could therefore vary considerably.

Method 3. Site Production History

Method 3 is, like Method 2, a type of farm or enterprise budget analysis that takes into account production, prices and costs. The analytical steps (equations 4-9) and variable definitions are identical for these two methods. The only real difference is the basis for determining the gain in production associated with irrigation (Q_{ij}). For Method 3, Q_{ij} is estimated from production history on the site (or adjoining or nearby fields of similar

quality). Additionally, Method 3 can potentially provide a more defensible estimate of the actual water made available to the plant (Nij) through on-site hydrological investigations. Some perspective on Nij can also be gained from simply comparing the diversion right (given efficiency of conveyance and application) to the estimated net irrigation need computed by SCS. An unknown may be the effect of "flood rights" or natural subirrigation.

By contrast, there is no obvious way to validate the actual amount of water made available to the plant on a county-average basis. The default assumption is, of course, to use the SCS "net irrigation" estimates.

Method 4. Supply Price Based on Investment Cost

The preceding methods describe approaches for valuing irrigation water based on displaced agricultural production or a Case A situation. An alternative situation is where the market price in a local potential or actual water market may be dominated by investment alternatives that can increase water supplies. The most obvious situation is investment in water storage, such as an upstream reservoir, that makes water available during the irrigation/recreational season that was previously lost in the spring runoff. The value of this water is simply the amortized present value of investment and operation and maintenance of the project over its useful life (Cl) divided by the available storage (S) or:

$$Wd,l = Cl/S \qquad (10)$$

Alternatively, for a project with fully amortized investment, a short run price that covers continuing variable costs is:

$$Ws,l = Cs/S \qquad (11)$$

This case seems fairly simple for a reservoir type of application. A more complex variant is where other types of investment are made, such as in improved efficiency of an irrigation system (for example change from a ditch to a pipeline and from flood to sprinkler). One way to look at this case is that there are actually multiple outputs from the project: water conveyed to a field at some level of pressure (which can displace pumps with a gravity sprinkler) plus water now available to be diverted in the stream. This raises the issue of how costs should be shared among the outputs and how the output quantities are to be defined.

From an economic efficiency standpoint, this is similar to the case of a business firm with multiple outputs. A basic analytical result in this area of microeconomic theory is that there is no clear way to allocate joint costs of production. An alternative

is to examine the problem from the standpoint of "fairness". Several approaches seem possible. One is to simply assume that the uses are equal in "worthiness" and share costs based on actual water use. Where "I" is the water diverted for irrigation and "F" is the instream flow increment from the investment, then the share paid for instream flow of the total investment C1 might be the ratio of F/(I + F). An issue is whether C1 should include just the costs of a conveyance system or also the ranchers investment in sprinklers, etc.

An alternative "fairness" proposition would be to compute cost-shares in proportion to net returns. This would require an independent estimate of what the instream flow is worth.

A third proposition would be to develop a simulation model of alternative price and production combinations projected out for the life of the project. Prices and production could be based on the variance in the actual historical record for the given crop. A number of these project "futures" could be run and the statistical distribution of net return to irrigators over the life of the project could be computed. The effect on net returns of having an increasing share of investment costs covered by instream flows could also be computed. A "fair share" might be at the level which reduces the possibility of a negative net return to the irrigation investment (from the irrigator's standpoint) to some specific low probability, such as 1 percent. In other words, it may be "fair" for instream flow payments to reduce project uncertainty from the ranchers standpoint to near zero.

Once one deviates from the simple reservoir-type supply cost model, there is no clear analytical basis for a fair sharing of investment costs in a multiple-output model. Accordingly, it may be necessary to examine all three (or more) of the "fairness" based scenarios and establish a price through negotiation.

It is also possible in some situations that a value could be assigned based on displaced agricultural production, for example if the land base is large and there are many feasible alternative levels of investment (scale of the project). However, given a limited land base associated with a project, more typically the feasible or least-cost state of the project may be well defined with the net return beyond some point being near zero.

5. RESULTS OF GENERAL METHODS FOR VALUING IRRIGATION WATER IN SELECTED MONTANA COUNTIES

Several of the assumptions of the general methods for valuing agricultural water have been touched on thus far. Before proceeding with an analysis of those methods, and the water values which are estimated using them, it is important to note the limitations of the two methods. Perhaps most important is

the fact that both methods are based on the use of aggregated data and, therefore, provide only "ballpark" estimates of the value of any particular water right. The county specific comparison of yields of irrigated and nonirrigated land provides average water values for most crops in each county, but these estimated values will not necessarily equal the water values on any specific farm. A second limitation of the general methods lies in the fact that they do not provide value estimates for all crops in all counties. Comparisons of irrigated and nonirrigated yields could not be made in counties where there was either no irrigated or no nonirrigated land for a particular crop. Additionally, in cases where there was a very small amount of land in a county planted in a particular crop, estimates which were made should be viewed with caution.

A limitation specific to the yield comparison method of valuation lies in the estimation of costs associated with different types of irrigation systems (flood, wheel line and center pivot). All farmers who irrigate using a flood system do not have the same per acre costs of irrigation. The same is true for sprinkler irrigators. Out of practical necessity the cost estimates (both short run and long run) reported here are average costs from which case specific costs may vary widely. The average short run cost of flood irrigation used here is an average representative cost of the labor needed for handline irrigation (roughly $20 per acre for alfalfa and wild hays and $10 per acre for small grains). This is assumed to be the maximum cost associated with flood irrigation. In many cases actual costs will be lower, and estimates should be adjusted to reflect this. Power costs for sprinkler pumping were assumed to be 44.225 kwh per acre/inch pumped priced at a 1989 average agricultural rate of 4 cents kwh (Fogel and Luft, 1980). Labor, operation and maintenance of sprinkler systems were assumed to be $7.05/acre for wheel lines and $14.25/acre for center pivot systems (Greiman, 1990). Finally, long run equipment costs were assumed at an original cost of $250/acre for wheel lines, $350/acre for center pivot systems and $50 for flood. While investments in flood irrigation can be sizable (traveling dams, lined ditches, etc.) there are many flood irrigation systems which with a minimum of maintenance operate on very minimal investments. These investments were amortized over 20 years at an assumed real rate of 4.6% (DNRC, 1989). Again, these are average figures which may vary widely depending on topography, and system design. It is noteworthy that all three types of irrigation systems are not used routinely on all crops even though water values are reported for these systems. Wild hay, for instance, is almost always flooded as sprinkler irrigation is not economically feasible (Bjergo, 1990).

One final word of caution deals with costs and revenues not addressed in this report. An irrigation system which appears uneconomical using these numbers might be much more attractive when hidden sources of revenue such as government price supports,

matching funds for system improvements are considered or further on-farm processing (such as using hay for feeding cattle). Also, the existence of a high pressure pipeline which conveys water to farmers can eliminate power pumping costs, and thus make a sprinkling system more attractive and the water it uses more valuable.

The crop-water production function value estimates were used primarily as a validation of the county-level comparison methodology, But it can also be viewed as a stand-alone valuation method for at-the-crop water used for irrigated alfalfa. Because use of this method depends on the availability of research data for specific crops, its use was limited to valuing water used in the production of alfalfa. However, since alfalfa constitutes 33% of the harvested cropland in the eight counties of interest, this method is significant as a valuation technique for water used on Montana cropland. Table 4 shows which crops each method is capable of addressing.

Table 4

Agricultural Water Valuation Techniques Methodologies and Their Limitations

Crop	Crop-Water Production Functions	Comparison of Irr. and Nonirr. Yields
Alfalfa Hay	Yes	Yes
Wild Hay	No	Yes
<u>Small Grains</u>		
Barley	No	Yes
Oats	No	Yes*
Spring Wheat	No	Yes*
Winter Wheat	No	Yes*

* Asterisk denotes that care must be taken in interpreting values for certain counties as estimates are based on small acreages and may be biased.

Comparison of Irrigated and Nonirrigated Production Based on County-level Historical Data

Comparing yields of irrigated and nonirrigated lands is a special case of a more general method of agricultural water valuation known as farm budget analysis. This comparison method looks at crop yields from irrigated and nonirrigated lands which are similar in productivity to determine the addition to total yield which irrigation brings about. This comparison methodology has been the preferred method of the United States Water Resources Council (Gibbons, 1986). In the research literature this method is not often used because of the difficulty in finding irrigated and nonirrigated lands growing identical crops which have the same soils, exposure, rainfall, etc.. A general application of this method is possible in the case of Montana agriculture because of the existence of two sources of Montana agricultural data. The Montana Agricultural Statistics Service (MASS) publishes a yearly summary of county-by-county acres harvested and average yields for each crop grown in Montana. These statistics are published for both irrigated and nonirrigated cropland in each county. This MASS data base combined with Soil Conservation Service estimates of crop specific water consumption for each county provide the information necessary to perform the comparison. Of course a county level data base does not guarantee identical soils, exposure and rainfall. As noted previously, it is likely that the better soils are irrigated which implies that the following estimates may provide an upper bound to the influence of irrigation water on crop yield.

In implementing this county specific historical yield comparison four general steps were followed: 1) a gross crop value per acre was calculated for both irrigated and nonirrigated lands in each county, 2) The average per acre difference in gross crop value was calculated for each crop in each county, 3) irrigation costs for three alternative types of irrigation technologies were subtracted from the average per acre difference in crop value to arrive at a net value per acre of irrigation water, 4) the net value per acre was divided by the county and crop specific irrigation requirements as specified by the SCS to arrive at a per acre/foot value of irrigation water.

Tables 5-16 show for both irrigated and nonirrigated cropland the average number of acres harvested, the average yield per acre, the 3 year (1987, 1988 and 1989) price for the crop and the gross crop value per acre. Because of the large year to year changes in crop unit prices due to market conditions, we did not bother to correct the 1987-1989 price series for the relatively small change due to inflation in these years. The prices can be interpreted as being in approximately 1988 dollars. Missing cells in the tables indicate that none of the crop was grown using a specific method (irrigated or nonirrigated) in a specific county. Tables 17-22 show the difference in average yields

between irrigated and nonirrigated croplands and how that difference translates into the average difference in the gross value of the crops grown per acre. Certain yield differences are marked with an asterisk. This denotes that one or both of the average acreages upon which the difference is based was lower than 500 acres. Therefore, values derived from these asterisked yield differences should be interpreted with caution as 1 or 2 particularly well, or poorly, managed farms, or farms with very different soil qualities, could significantly affect the value estimates. Tables 23-34 subtract average annual irrigation costs for flood, sidewheel and center pivot systems from the gross difference in value per acre from Tables 17-22. Tables 23-28 subtract out only short run costs of operating the systems in order to estimate short run values for the water. These short run costs are labor costs of operating the systems, electrical costs and other operation and maintenance costs. Tables 29-34 additionally subtracts out long run costs associated with the systems. These costs include the amortized cost of any equipment used in the irrigation process. It is in this set of tables that the assumption that all crops reach their maximum, or potential, evapotranspiration level becomes most significant. While it may be reasonable to assume that sprinkler systems such as a sidewheel or center pivot system provide an adequate level of water to crops to meet their potential ET needs the assumption is not as reasonable in the case of flood irrigation. Because of the inefficiencies of many flood systems, crops watered this way often fall short of their maximum ET levels and yields are reduced. The result of this potential bias may be that the value figures for flood irrigation are somewhat overstated. There is no obvious way around this problem other than site specific hydrologic investigations.

The per acre crop value which is added by irrigation can be converted into a per acre/foot value if the amount of irrigation water used in the crop production process is known (following equations 6 to 9 in section 4). Tables 35-40 show crop and county specific net irrigation requirements. These requirements are from the SCS Montana Irrigation Manual and were calculated in that publication for weather stations throughout Montana. Certain counties of interest to DFWP did not have reporting weather stations so irrigation requirements for nearby weather stations in the same climactic zone, and of a similar altitude, were used in proxy. The net irrigation requirement figures from tables 35-40 were then used to convert the per acre net value of irrigation water figures to per acre foot values. The results of these calculations are shown in tables 41-58.

Recommendations for Use of County Comparison Tables

The computational detail (53 tables) included with the county comparison method of water valuation is provided to facilitate use of the method and it's estimates. The aim of the authors was

to present the derivation of the estimates in a transparent manner which would provide maximum flexibility in applying the estimates to actual water leasing cases. For example, if the yields, costs or irrigation efficiencies associated with a particular water right did not match the assumed values used in the average value calculations alternative figures can be plugged in to the tables at any point, and the new (more site-tailored) estimates can be calculated. When site-specific cost, yield or efficiency estimates are available these <u>should</u> be used in place of the average or assumed values in the tables in order to provide the most accurate inputs to the value estimation process.

Table 5
Irrigated Montana Cropland
Average Acreage and Yields, by County
1980-1988
Alfalfa Hay

County	Acres	Yield/acre	Price	Gross/acre ($)
Beaverhead	40,388	3.31	65.19	215.78
Broadwater	13,633	3.52	65.19	229.47
Deerlodge	5933	2.84	65.19	185.14
Jefferson	10,956	3.13	65.19	204.04
Lewis & Clark	20,511	3.10	65.19	202.09
Meagher	9911	2.61	65.19	170.15
Park	26,256	2.68	65.19	174.71
Ravalli	19,733	3.54	65.19	230.77

Notes: Acres = Average Harvested Acres
Yield/acre = Yield in tons per acre
Price = Three year average price (1987, 1988 and 1989)

Table 6
Nonirrigated Montana Cropland
Average Acreage and Yields, by County
1980-1988
Alfalfa Hay

County	Acres	Yield/acre	Price	Gross/acre ($)
Beaverhead	1111	1.18	65.19	76.92
Broadwater	1378	1.29	65.19	84.10
Deerlodge	211	1.31	65.19	85.40
Jefferson	911	1.49	65.19	97.13
Lewis & Clark	5989	1.24	65.19	80.83
Meagher	2089	1.26	65.19	82.14
Park	6511	1.59	65.19	103.65
Ravalli	889	1.70	65.19	110.82

Notes: Acres = Average Harvested Acres
Yield/acre = Yield in tons per acre
Price = Three year average price (1987, 1988 and 1989)

Table 7
Irrigated Montana Cropland
Average Acreage and Yields, by County
1980-1988
Barley

County	Acres	Yield/acre	Price	Gross/acre ($)
Beaverhead	7567	68.9	2.28	157.09
Broadwater	8189	69.3	2.28	158.00
Deerlodge	989	64.6	2.28	147.29
Jefferson	1855	64.0	2.28	145.92
Lewis & Clark	4811	59.0	2.28	134.32
Meagher	1989	57.1	2.28	130.19
Park	2433	60.6	2.28	138.17
Ravalli	4044	67.9	2.28	154.81

Notes: Acres = Average Harvested Acres
Yield/acre = Yield in bushels per acre
Price = Three year average price (1987, 1988 and 1989)

Table 8
Nonirrigated Montana Cropland
Average Acreage and Yields, by County
1980-1988
Barley

County	Acres	Yield/acre	Price	Gross/acre ($)
Beaverhead	2156	37.8	2.28	86.18
Broadwater	10,244	35.9	2.28	81.85
Deerlodge	267	30.8	2.28	70.22
Jefferson	1611	35.4	2.28	80.71
Lewis & Clark	3989	31.8	2.28	72.50
Meagher	14,456	31.6	2.28	72.05
Park	7000	37.7	2.28	85.96
Ravalli	1844	35.3	2.28	80.48

Notes: Acres = Average Harvested Acres
Yield/acre = Yield in bushels per acre
Price = Three year average price (1987, 1988 and 1989)

Table 9
Irrigated Montana Cropland
Average Acreage and Yields, by County
1980-1988
Oats

County	Acres	Yield/acre	Price	Gross/acre ($)
Beaverhead	489	75.8	1.73	131.13
Broadwater	667	75.7	1.73	130.93
Deerlodge	-	-	-	-
Jefferson	622	70.4	1.73	121.79
Lewis & Clark	900	67.6	1.73	116.95
Meagher	489	65.7	1.73	113.70
Park	778	68.7	1.73	118.85
Ravalli	767	76.7	1.73	132.69

Notes: Acres = Average Harvested Acres
Yield/acre = Yield in bushels per acre
Price = Three year average price (1987, 1988 and 1989)

Table 10
Nonirrigated Montana Cropland
Average Acreage and Yields, by County
1980-1988
Oats

County	Acres	Yield/acre	Price	Gross/acre ($)
Beaverhead	-	-	-	-
Broadwater	244	32.3	1.73	55.88
Deerlodge	-	-	-	-
Jefferson	167	30.1	1.73	52.07
Lewis & Clark	133	30.0	1.73	51.90
Meagher	633	39.9	1.73	69.03
Park	355	38.1	1.73	65.91
Ravalli	144	31.0	1.73	53.63

Notes: Acres = Average Harvested Acres
Yield/acre = Yield in bushels per acre
Price = Three year average price (1987, 1988 and 1989)

Table 11
Irrigated Montana Cropland
Average Acreage and Yields, by County
1980-1988
Other Hays

County	Acres	Yield/acre	Price	Gross/acre ($)
Beaverhead	45,650	1.45	57.78	83.78
Broadwater	4850	1.66	57.78	95.91
Deerlodge	6100	1.36	57.78	78.58
Jefferson	14,087	1.50	57.78	86.67
Lewis & Clark	8375	1.64	57.78	94.76
Meagher	26,863	1.56	57.78	90.14
Park	18,338	1.78	57.78	102.85
Ravalli	15,925	1.88	57.78	108.63

Notes: Acres = Average Harvested Acres
Yield/acre = Yield in tons per acre
Price = Three year average price (1987, 1988 and 1989)

Table 12
Nonirrigated Montana Cropland
Average Acreage and Yields, by County
1980-1988
Other Hays

County	Acres	Yield/acre	Price	Gross/acre ($)
Beaverhead	2913	.85	57.78	49.11
Broadwater	825	.95	57.78	54.89
Deerlodge	-	-	-	-
Jefferson	1175	.98	57.78	56.62
Lewis & Clark	6263	1.05	57.78	60.67
Meagher	4725	1.09	57.78	62.98
Park	3850	1.11	57.78	64.14
Ravalli	625	.78	57.78	45.07

Notes: Acres = Average Harvested Acres
Yield/acre = Yield in tons per acre
Price = Three year average price (1987, 1988 and 1989)

Table 13
Irrigated Montana Cropland
Average Acreage and Yields, by County
1980-1988
Spring Wheat

County	Acres	Yield/acre	Price	Gross/acre ($)
Beaverhead	5622	60.1	3.49	209.75
Broadwater	9400	60.2	3.49	210.10
Deerlodge	122	38.7	3.49	135.06
Jefferson	189	39.7	3.49	138.55
Lewis & Clark	1500	52.5	3.49	183.23
Meagher	200	27.3	3.49	95.28
Park	322	34.0	3.49	118.67
Ravalli	900	59.6	3.49	208.00

Notes: Acres = Average Harvested Acres
Yield/acre = Yield in bushels per acre
Price = Three year average price (1987, 1988 and 1989)

Table 14
Nonirrigated Montana Cropland
Average Acreage and Yields, by County
1980-1988
Spring Wheat

County	Acres	Yield/acre	Price	Gross/acre ($)
Beaverhead	2544	27.0	3.49	94.23
Broadwater	8077	25.2	3.49	87.95
Deerlodge	244	25.2	3.49	87.95
Jefferson	1567	27.2	3.49	94.93
Lewis & Clark	1656	23.1	3.49	80.62
Meagher	633	16.2	3.49	56.54
Park	1678	23.4	3.49	81.67
Ravalli	311	20.8	3.49	72.59

Notes: Acres = Average Harvested Acres
Yield/acre = Yield in bushels per acre
Price = Three year average price (1987, 1988 and 1989)

Table 15
Irrigated Montana Cropland
Average Acreage and Yields, by County
1980-1988
Winter Wheat

County	Acres	Yield/acre	Price	Gross/acre ($)
Beaverhead	200	44.3	3.42	151.51
Broadwater	544	55.7	3.42	190.49
Deerlodge	-	-	-	-
Jefferson	-	-	-	-
Lewis & Clark	122	26.1	3.42	89.26
Meagher	-	-	-	-
Park	388	48.3	3.42	165.19
Ravalli	178	38.9	3.42	133.04

Notes: Acres = Average Harvested Acres
Yield/acre = Yield in Bushels per acre
Price = Three year average price (1987, 1988 and 1989)

Table 16
Nonirrigated Montana Cropland
Average Acreage and Yields, by County
1980-1988
Winter Wheat

County	Acres	Yield/acre	Price	Gross/acre ($)
Beaverhead	3789	35.6	3.42	121.75
Broadwater	19,500	31.1	3.42	106.36
Deerlodge	-	-	-	-
Jefferson	5444	32.7	3.42	111.83
Lewis & Clark	10,789	30.8	3.42	105.34
Meagher	7411	27.3	3.42	93.37
Park	9722	30.7	3.42	104.99
Ravalli	1300	34.3	3.42	117.31

Notes: Acres = Average Harvested Acres
Yield/acre = Yield in bushels per acre
Price = Three year average price (1987, 1988 and 1989)

Table 17
Irrigated v. Nonirrigated Land
Difference in Yield and Gross Crop Value
1980-1988
Alfalfa Hay

County	Yield Difference	Gross Difference ($)
Beaverhead	2.13	138.86
Broadwater	2.23	145.39
Deerlodge	1.53*	99.74
Jefferson	1.64	106.91
Lewis & Clark	1.86	121.26
Meagher	1.35	87.97
Park	1.09	71.06
Ravalli	1.84	119.95

Note: Values marked with an asterisk are based on small acreage estimates and thus may be unreliable.
Yield Difference is in tons per acre.

Table 18
Irrigated v. Nonirrigated Land
Difference in Yield and Gross Crop Value
1980-1988
Barley

County	Yield Difference	Gross Difference ($)
Beaverhead	31.1	70.91
Broadwater	33.4	76.15
Deerlodge	33.8*	77.07
Jefferson	28.6	65.21
Lewis & Clark	27.2	61.82
Meagher	25.5	58.14
Park	22.9	52.21
Ravalli	32.6	74.33

Note: Values marked with an asterisk are based on small acreage estimates and thus may be unreliable.
Yield difference is in bushels per acre.

Table 19

Irrigated v. Nonirrigated Land
Difference in Yield and Gross Crop Value
1980-1988
Oats

County	Yield Difference	Gross Difference ($)
Beaverhead	-	-
Broadwater	43.4*	75.05
Deerlodge	-	-
Jefferson	40.3*	69.72
Lewis & Clark	37.6*	65.05
Meagher	25.8*	44.67
Park	30.6*	52.94
Ravalli	45.7*	79.06

Note: Values marked with an asterisk are based on small acreage estimates and thus may be unreliable.
Yield difference is in Bushels per acre.

Table 20
Irrigated v. Nonirrigated Land
Difference in Yield and Gross Crop Value
1980-1988
Other Hays

County	Yield Difference	Gross Difference ($)
Beaverhead	.60	34.67
Broadwater	.71	41.02
Deerlodge	-	-
Jefferson	.52	30.05
Lewis & Clark	.59	34.09
Meagher	.47	27.16
Park	.67	36.71
Ravalli	1.10	63.56

Note: Values marked with an asterisk are based on small acreage estimates and thus may be unreliable.
Yield difference is in tons per acre.

Table 21
Irrigated v. Nonirrigated Land
Difference in Yield and Gross Crop Value
1980-1988
Spring Wheat

County	Yield Difference	Gross Difference ($)
Beaverhead	33.1	115.52
Broadwater	35.0	122.15
Deerlodge	13.5*	47.11
Jefferson	12.5*	43.62
Lewis & Clark	29.4	102.61
Meagher	11.1*	38.74
Park	10.6*	37.00
Ravalli	38.8*	135.41

Note: Values marked with an asterisk are based on small acreage estimates and thus may be unreliable.
Yield difference is in bushels per acre.

Table 22
Irrigated v. Nonirrigated Land
Difference in Yield and Gross Crop Value
1980-1988
Winter Wheat

County	Yield Difference	Gross Difference ($)
Beaverhead	8.7*	29.76
Broadwater	24.6	84.13
Deerlodge	-	-
Jefferson	-	-
Lewis & Clark	(4.7)*	(16.08)
Meagher	-	-
Park	17.6*	60.20
Ravalli	4.6*	15.73

Note: Values marked with an asterisk are based on small acreage estimates and thus may be unreliable.
Yield differences are in bushels per acre.

Table 23
Short Run Net Value of Irrigation to Cropland
Per Acre Estimates for Varying Irrigation Systems
1980-1988
Alfalfa Hay

County	Irr. System	Gross Value Per Acre	Annual S.R. Irr.Cost	S.R. Net Value/acre
Beaverhead	Flood	138.86	20.00	118.85
	Wheel Line	138.86	26.63	112.22
	Center Pivot	138.86	33.83	105.02
Broadwater	Flood	145.39	20.00	125.37
	Wheel Line	145.39	36.17	109.21
	Center Pivot	145.39	43.37	102.01
Deerlodge	Flood	99.74*	20.00	79.74
	Wheel Line	99.74*	21.47	78.27
	Center Pivot	99.74*	28.67	71.07
Jefferson	Flood	106.91	20.00	86.91
	Wheel Line	106.91	27.27	79.64
	Center Pivot	106.91	34.47	72.44
Lewis & Clark	Flood	121.26	20.00	101.25
	Wheel Line	121.26	36.17	85.09
	Center Pivot	121.26	43.37	77.89
Meagher	Flood	87.97	20.00	68.01
	Wheel Line	87.97	26.58	61.43
	Center Pivot	87.97	33.78	54.23
Park	Flood	71.06	20.00	51.06
	Wheel Line	71.06	32.05	39.01
	Center Pivot	71.06	39.25	31.81
Ravalli	Flood	119.95	20.00	99.95
	Wheel Line	119.95	34.43	85.52
	Center Pivot	119.95	41.63	78.32

* Asterisk denotes values which were derived from small acreage samples and thus may be unreliable.

Note: Gross value per acre is the average additional gross crop value of irrigated over nonirrigated land.

Table 24
Short Run Net Value of Irrigation to Cropland
Per Acre Estimates for Varying Irrigation Systems
1980-1988
Barley

County	Irr. System	Gross Value Per Acre	Annual S.R. Irr.Cost	S.R. Net Value/acre
Beaverhead	Flood	70.91	10.00	60.91
	Wheel Line	70.91	17.96	52.94
	Center Pivot	70.91	25.16	45.74
Broadwater	Flood	76.15	10.00	66.15
	Wheel Line	76.15	23.86	52.30
	Center Pivot	76.15	31.06	45.10
Deerlodge	Flood	77.07*	10.00	67.06
	Wheel Line	77.07*	13.28	63.79
	Center Pivot	77.07*	20.48	56.59
Jefferson	Flood	65.21	10.00	55.21
	Wheel Line	65.21	21.40	43.81
	Center Pivot	65.21	28.60	36.61
Lewis & Clark	Flood	61.82	10.00	52.02
	Wheel Line	61.82	23.86	38.16
	Center Pivot	61.82	31.06	30.96
Meagher	Flood	58.14	10.00	48.14
	Wheel Line	58.14	19.13	39.01
	Center Pivot	58.14	26.33	31.81
Park	Flood	52.21	10.00	42.21
	Wheel Line	52.21	19.77	32.44
	Center Pivot	52.21	26.97	25.24
Ravalli	Flood	74.33	10.00	64.33
	Wheel Line	74.33	20.39	53.94
	Center Pivot	74.33	27.59	46.74

* Asterisk denotes values which were derived from small acreage samples and thus may be unreliable.

Note: Gross value per acre is the average additional gross crop value of irrigated over nonirrigated land.

Table 25
Short Run Net Value of Irrigation to Cropland
Per Acre Estimates for Varying Irrigation Systems
1980-1988
Oats

County	Irr. System	Gross Value Per Acre	Annual S.R. Irr.Cost	S.R. Net Value/acre
Beaverhead	Flood	-	-	-
	Wheel Line	-	-	-
	Center Pivot	-	-	-
Broadwater	Flood	75.05*	10.00	65.08
	Wheel Line	75.05*	23.86	51.23
	Center Pivot	75.05*	31.06	44.03
Deerlodge	Flood	-	-	-
	Wheel Line	-	-	-
	Center Pivot	-	-	-
Jefferson	Flood	69.72*	10.00	59.72
	Wheel Line	69.72*	21.40	48.32
	Center Pivot	69.72*	28.60	41.12
Lewis & Clark	Flood	65.05*	10.00	55.05
	Wheel Line	65.05*	23.86	41.19
	Center Pivot	65.05*	31.06	33.99
Meagher	Flood	44.67*	10.00	34.63
	Wheel Line	44.67*	19.13	25.50
	Center Pivot	44.67*	26.33	18.30
Park	Flood	52.94*	10.00	42.94
	Wheel Line	52.94*	19.77	33.17
	Center Pivot	52.94*	26.97	25.97
Ravalli	Flood	79.06*	10.00	69.06
	Wheel Line	79.06*	20.39	58.67
	Center Pivot	79.06*	27.59	51.47

* Asterisk denotes values which were derived from small acreage samples and thus may be unreliable.

Note: Gross value per acre is the average additional gross crop value of irrigated over nonirrigated land.

Table 26
Short Run Net Value of Irrigation to Cropland
Per Acre Estimates for Varying Irrigation Systems
1980-1988
Other Hays

County	Irr. System	Gross Value Per Acre	Annual S.R. Irr.Cost	S.R. Net Value/acre
Beaverhead	Flood	34.67	20.00	14.67
	Wheel Line	34.67	24.89	9.78
	Center Pivot	34.67	32.09	2.58
Broadwater	Flood	41.02	20.00	21.02
	Wheel Line	41.02	31.44	9.58
	Center Pivot	41.02	38.64	2.38
Deerlodge	Flood	-	-	-
	Wheel Line	-	-	-
	Center Pivot	-	-	-
Jefferson	Flood	30.05	20.00	10.05
	Wheel Line	30.05	25.78	4.26
	Center Pivot	30.05	32.98	-2.94
Lewis & Clark	Flood	34.09	20.00	14.09
	Wheel Line	34.09	31.44	2.65
	Center Pivot	34.09	38.64	-4.55
Meagher	Flood	27.16	20.00	7.16
	Wheel Line	27.16	25.98	1.18
	Center Pivot	27.16	33.18	-6.02
Park	Flood	36.71	20.00	18.71
	Wheel Line	36.71	29.36	9.36
	Center Pivot	36.71	36.56	2.16
Ravalli	Flood	63.56	20.00	43.56
	Wheel Line	63.56	30.28	33.28
	Center Pivot	63.56	37.48	26.08

* Asterisk denotes values which were derived from small acreage samples and thus may be unreliable.

Note: Gross value per acre is the average additional gross crop value of irrigated over nonirrigated land.

Table 27

Short Run Net Value of Irrigation to Cropland
Per Acre Estimates for Varying Irrigation Systems
1980-1988
Spring Wheat

County	Irr. System	Gross Value Per Acre	Annual S.R. Irr.Cost	S.R.Net Value/acre
Beaverhead	Flood	115.52	10.00	105.52
	Wheel Line	115.52	17.97	97.55
	Center Pivot	115.52	25.17	90.35
Broadwater	Flood	122.15	10.00	112.15
	Wheel Line	122.15	23.86	98.29
	Center Pivot	122.15	31.06	91.09
Deerlodge	Flood	47.11*	10.00	37.12
	Wheel Line	47.11*	13.28	33.84
	Center Pivot	47.11*	20.48	26.64
Jefferson	Flood	43.62*	10.00	33.63
	Wheel Line	43.62*	21.40	22.23
	Center Pivot	43.62*	28.60	15.03
Lewis & Clark	Flood	102.61	10.00	92.61
	Wheel Line	102.61	23.86	78.75
	Center Pivot	102.61	31.06	71.55
Meagher	Flood	38.74*	10.00	28.74
	Wheel Line	38.74*	19.13	19.61
	Center Pivot	38.74*	26.33	12.41
Park	Flood	37.00*	10.00	26.99
	Wheel Line	37.00*	19.77	17.22
	Center Pivot	37.00*	26.97	10.02
Ravalli	Flood	135.41	10.00	125.41
	Wheel Line	135.41	20.39	115.02
	Center Pivot	135.41	27.59	107.82

* Asterisk denotes values which were derived from small acreage samples and thus may be unreliable.

Note: Gross value per acre is the average additional gross crop value of irrigated over nonirrigated land.

Table 28
Short Run Net Value of Irrigation to Cropland
Per Acre Estimates for Varying Irrigation Systems
1980-1988
Winter Wheat

County	Irr. System	Gross Value Per Acre	Annual S.R. Irr.Cost	S.R. Net Value/acre
Beaverhead	Flood	29.76*	10.00	19.75
	Wheel Line	29.76*	18.41	11.35
	Center Pivot	29.76*	25.61	4.15
Broadwater	Flood	84.13	10.00	74.13
	Wheel Line	84.13	18.88	65.25
	Center Pivot	84.13	26.08	58.05
Deerlodge	Flood	-	-	-
	Wheel Line	-	-	-
	Center Pivot	-	-	-
Jefferson	Flood	-	-	-
	Wheel Line	-	-	-
	Center Pivot	-	-	-
Lewis & Clark	Flood	(16.08)*	10.00	-26.07
	Wheel Line	(16.08)*	18.88	-34.96
	Center Pivot	(16.08)*	26.08	-42.16
Meagher	Flood	-	-	-
	Wheel Line	-	-	-
	Center Pivot	-	-	-
Park	Flood	60.20*	10.00	50.91
	Wheel Line	60.20*	14.89	45.31
	Center Pivot	60.20*	22.09	38.11
Ravalli	Flood	15.73*	10.00	5.73
	Wheel Line	15.73*	15.36	0.37
	Center Pivot	15.73*	22.56	-6.83

* Asterisk denotes values which were derived from small acreage samples and thus may be unreliable.

Note: Gross value per acre is the average additional gross crop value of irrigated over nonirrigated land.

Table 29
Long Run Net Value of Irrigation to Cropland
Per Acre Estimates for Varying Irrigation Systems
1980-1988
Alfalfa Hay

County	Irr. System	Gross Value Per Acre	Annual L.R. Irr.Cost	L.R. Net Value/acre
Beaverhead	Flood	138.86	3.88	114.98
	Wheel Line	138.86	19.39	92.84
	Center Pivot	138.86	27.14	77.88
Broadwater	Flood	145.39	3.88	121.50
	Wheel Line	145.39	19.39	89.82
	Center Pivot	145.39	27.14	74.87
Deerlodge	Flood	99.74*	3.88	75.86
	Wheel Line	99.74*	19.39	58.89
	Center Pivot	99.74*	27.14	43.93
Jefferson	Flood	106.91	3.88	83.03
	Wheel Line	106.91	19.39	60.26
	Center Pivot	106.91	27.14	45.30
Lewis & Clark	Flood	121.26	3.88	97.38
	Wheel Line	121.26	19.39	65.70
	Center Pivot	121.26	27.14	50.75
Meagher	Flood	87.97	3.88	64.13
	Wheel Line	87.97	19.39	42.04
	Center Pivot	87.97	27.14	27.09
Park	Flood	71.06	3.88	47.18
	Wheel Line	71.06	19.39	19.63
	Center Pivot	71.06	27.14	4.67
Ravalli	Flood	119.95	3.88	96.07
	Wheel Line	119.95	19.39	66.13
	Center Pivot	119.95	27.14	51.18

* Asterisk denotes values which were derived from small acreage samples and thus may be unreliable.

Note: Gross value per acre is the average additional gross crop value of irrigated over nonirrigated land.

Table 30
Long Run Net Value of Irrigation to Cropland
Per Acre Estimates for Varying Irrigation Systems
1980-1988
Barley

County	Irr. System	Gross Value Per Acre	Annual L.R. Irr.Cost	L.R. Net Value/acre
Beaverhead	Flood	70.91	3.88	57.03
	Wheel Line	70.91	19.39	33.56
	Center Pivot	70.91	27.14	18.60
Broadwater	Flood	76.15	3.88	62.29
	Wheel Line	76.15	19.39	32.91
	Center Pivot	76.15	27.14	17.96
Deerlodge	Flood	77.07*	3.88	63.19
	Wheel Line	77.07*	19.39	44.40
	Center Pivot	77.07*	27.14	29.45
Jefferson	Flood	65.21	3.88	51.33
	Wheel Line	65.21	19.39	24.43
	Center Pivot	65.21	27.14	9.47
Lewis & Clark	Flood	61.82	3.88	48.14
	Wheel Line	61.82	19.39	18.77
	Center Pivot	61.82	27.14	3.82
Meagher	Flood	58.14	3.88	44.26
	Wheel Line	58.14	19.39	19.62
	Center Pivot	58.14	27.14	4.67
Park	Flood	52.21	3.88	38.33
	Wheel Line	52.21	19.39	13.06
	Center Pivot	52.21	27.14	-1.90
Ravalli	Flood	74.33	3.88	60.45
	Wheel Line	74.33	19.39	34.55
	Center Pivot	74.33	27.14	19.60

* Asterisk denotes values which were derived from small acreage samples and thus may be unreliable.

Note: Gross value per acre is the average additional gross crop value of irrigated over nonirrigated land.

Table 31
Long Run Net Value of Irrigation to Cropland
Per Acre Estimates for Varying Irrigation Systems
1980-1988
Oats

County	Irr. System	Gross Value Per Acre	Annual L.R. Irr.Cost	L.R. Net Value/acre
Beaverhead	Flood	-	-	-
	Wheel Line	-	-	-
	Center Pivot	-	-	-
Broadwater	Flood	75.05*	3.88	61.20
	Wheel Line	75.05*	19.39	31.84
	Center Pivot	75.05*	27.14	16.89
Deerlodge	Flood	-	-	-
	Wheel Line	-	-	-
	Center Pivot	-	-	-
Jefferson	Flood	69.72*	3.88	55.84
	Wheel Line	69.72*	19.39	28.94
	Center Pivot	69.72*	27.14	13.98
Lewis & Clark	Flood	65.05*	3.88	51.17
	Wheel Line	65.05*	19.39	21.81
	Center Pivot	65.05*	27.14	6.85
Meagher	Flood	44.67*	3.88	30.76
	Wheel Line	44.67*	19.39	6.12
	Center Pivot	44.67*	27.14	-8.84
Park	Flood	52.94*	3.88	39.06
	Wheel Line	52.94*	19.39	13.78
	Center Pivot	52.94*	27.14	-1.17
Ravalli	Flood	79.06*	3.88	65.18
	Wheel Line	79.06*	19.39	39.29
	Center Pivot	79.06*	27.14	24.33

* Asterisk denotes values which were derived from small acreage samples and thus may be unreliable.

Note: Gross value per acre is the average additional gross crop value of irrigated over nonirrigated land.

Table 32
Long Run Net Value of Irrigation to Cropland
Per Acre Estimates for Varying Irrigation Systems
1980-1988
Other Hays

County	Irr. System	Gross Value Per Acre	Annual L.R. Irr.Cost	L.R. Net Value/acre
Beaverhead	Flood	34.67	3.88	10.79
	Wheel Line	34.67	19.39	-9.61
	Center Pivot	34.67	27.14	-24.56
Broadwater	Flood	41.02	3.88	17.15
	Wheel Line	41.02	19.39	-9.81
	Center Pivot	41.02	27.14	-24.76
Deerlodge	Flood	-	-	-
	Wheel Line	-	-	-
	Center Pivot	-	-	-
Jefferson	Flood	30.05	3.88	6.17
	Wheel Line	30.05	19.39	-15.12
	Center Pivot	30.05	27.14	-30.08
Lewis & Clark	Flood	34.09	3.88	10.21
	Wheel Line	34.09	19.39	-16.74
	Center Pivot	34.09	27.14	-31.69
Meagher	Flood	27.16	3.88	3.28
	Wheel Line	27.16	19.39	-18.21
	Center Pivot	27.16	27.14	-33.16
Park	Flood	36.71	3.88	14.84
	Wheel Line	36.71	19.39	-10.03
	Center Pivot	36.71	27.14	-24.98
Ravalli	Flood	63.56	3.88	39.68
	Wheel Line	63.56	19.39	13.90
	Center Pivot	63.56	27.14	-1.06

* Asterisk denotes values which were derived from small acreage samples and thus may be unreliable.

Note: Gross value per acre is the average additional gross crop value of irrigated over nonirrigated land.

Table 33
Long Run Net Value of Irrigation to Cropland
Per Acre Estimates for Varying Irrigation Systems
1980-1988
Spring Wheat

County	Irr. System	Gross Value Per Acre	Annual L.R. Irr.Cost	L.R. Net Value/acre
Beaverhead	Flood	115.52	3.88	101.64
	Wheel Line	115.52	19.39	78.16
	Center Pivot	115.52	27.14	63.21
Broadwater	Flood	122.15	3.88	108.27
	Wheel Line	122.15	19.39	78.91
	Center Pivot	122.15	27.14	63.95
Deerlodge	Flood	47.11*	3.88	33.24
	Wheel Line	47.11*	19.39	14.45
	Center Pivot	47.11*	27.14	-0.50
Jefferson	Flood	43.62*	3.88	29.75
	Wheel Line	43.62*	19.39	2.84
	Center Pivot	43.62*	27.14	-12.11
Lewis & Clark	Flood	102.61	3.88	88.73
	Wheel Line	102.61	19.39	59.36
	Center Pivot	102.61	27.14	44.41
Meagher	Flood	38.74*	3.88	24.86
	Wheel Line	38.74*	19.39	0.22
	Center Pivot	38.74*	27.14	-14.73
Park	Flood	37.00*	3.88	23.12
	Wheel Line	37.00*	19.39	-2.16
	Center Pivot	37.00*	27.14	-17.12
Ravalli	Flood	135.41	3.88	121.53
	Wheel Line	135.41	19.39	95.64
	Center Pivot	135.41	27.14	80.68

* Asterisk denotes values which were derived from small acreage samples and thus may be unreliable.

Note: Gross value per acre is the average additional gross crop value of irrigated over nonirrigated land.

Table 34
Long Run Net Value of Irrigation to Cropland
Per Acre Estimates for Varying Irrigation Systems
1980-1988
Winter Wheat

County	Irr. System	Gross Value Per Acre	Annual L.R. Irr.Cost	L.R. Net Value/acre
Beaverhead	Flood	29.76*	3.88	15.88
	Wheel Line	29.76*	19.39	-8.05
	Center Pivot	29.76*	27.14	-22.99
Broadwater	Flood	84.13	3.88	70.25
	Wheel Line	84.13	19.39	45.86
	Center Pivot	84.13	27.14	30.91
Deerlodge	Flood	-	-	-
	Wheel Line	-	-	-
	Center Pivot	-	-	-
Jefferson	Flood	-	-	-
	Wheel Line	-	-	-
	Center Pivot	-	-	-
Lewis & Clark	Flood	(16.08)*	3.88	-29.95
	Wheel Line	(16.08)*	19.39	-54.34
	Center Pivot	(16.08)*	27.14	-69.30
Meagher	Flood	-	-	-
	Wheel Line	-	-	-
	Center Pivot	-	-	-
Park	Flood	60.20*	3.88	46.31
	Wheel Line	60.20*	19.39	25.92
	Center Pivot	60.20*	27.14	10.97
Ravalli	Flood	15.73*	3.88	1.85
	Wheel Line	15.73*	19.39	-19.02
	Center Pivot	15.73*	27.14	-33.97

* Asterisk denotes values which were derived from small acreage samples and thus may be unreliable.

Note: Gross value per acre is the average additional gross crop value of irrigated over nonirrigated land.

Table 35
Montana Crop Irrigation Requirements
Estimated Seasonal Consumptive Use, SCS TR-21 Method
By County[1]
Alfalfa Hay

County	Weather Station	Elevation	Net Irrigation/in.
Beaverhead	Dillon	5216	13.99
	Lima	6275	8.15
Broadwater	Helena (Lewis & Clark)	3828	16.46
Deerlodge	Lima (Beaverhead)	6275	8.15
Jefferson	Boulder School	4904	11.43
Lewis & Clark	Helena	3828	16.46
Meagher	Harlowton (Wheatland)	4106	11.04
Park	Livingston	4490	14.13
Ravalli	Darby	3880	14.89
	Hamilton	3529	16.06

[1] If more than one weather station representative of agricultural zones occurs in a county the irrigation requirements are averaged. If there is no station in the county a nearby weather station of the same climactic zone and similar elevation was used.

Table 36
Montana Crop Irrigation Requirements
Estimated Seasonal Consumptive Use, SCS TR-21 Method
By County[1]
Barley (Spring Grain)

County	Weather Station	Elevation	Net Irrigation/in.
Beaverhead	Dillon	5216	8.83
	Lima	6275	3.52
Broadwater	Helena (Lewis & Clark)	3828	9.50
Deerlodge	Lima (Beaverhead)	6275	3.52
Jefferson	Boulder School	4904	8.11
Lewis & Clark	Helena	3828	9.50
Meagher	Harlowton (Wheatland)	4160	6.83
Park	Livingston	4490	7.19
Ravalli	Darby	3880	7.41
	Hamilton	3529	7.67

[1] If more than one weather station representative of agricultural zones occurs in a county the irrigation requirements are averaged. If there is no station in the county a nearby weather station of the same climactic zone and similar elevation was used.

Table 37
Montana Crop Irrigation Requirements
Estimated Seasonal Consumptive Use, SCS TR-21 Method
By County[1]
Oats (Spring Grain)

County	Weather Station	Elevation	Net Irrigation/in.
Beaverhead	Dillon	5216	8.83
	Lima	6275	3.52
Broadwater	Helena (Lewis & Clark)	3828	9.50
Deerlodge	Lima (Beaverhead)	6275	3.52
Jefferson	Boulder School	4904	8.11
Lewis & Clark	Helena	3828	9.50
Meagher	Harlowton (Wheatland)	4160	6.83
Park	Livingston	4490	7.19
Ravalli	Darby	3880	7.41
	Hamilton	3529	7.67

[1] If more than one weather station representative of agricultural zones occurs in a county the irrigation requirements are averaged. If there is no station in the county a nearby weather station of the same climactic zone and similar elevation was used.

Table 38
Montana Crop Irrigation Requirements
Estimated Seasonal Consumptive Use, SCS TR-21 Method
By County[1]
Other Hays (Irrigated Pasture)

County	Weather Station	Elevation	Net Irrigation/in.
Beaverhead	Dillon	5216	12.02
	Lima	6275	8.15
Broadwater	Helena (Lewis & Clark)	3828	13.79
Deerlodge	Lima (Beaverhead)	6275	8.15
Jefferson	Boulder School	4904	10.59
Lewis & Clark	Helena	3828	13.79
Meagher	Harlowton (Wheatland)	4160	10.70
Park	Livingston	4490	12.61
Ravalli	Darby	3880	12.97
	Hamilton	3529	13.29

[1] If more than one weather station representative of agricultural zones occurs in a county the irrigation requirements are averaged. If there is no station in the county a nearby weather station of the same climactic zone and similar elevation was used.

Table 39

Montana Crop Irrigation Requirements
Estimated Seasonal Consumptive Use, SCS TR-21 Method
By County[1]
Spring Wheat (Spring Grains)

County	Weather Station	Elevation	Net Irrigation/in.
Beaverhead	Dillon	5216	8.83
	Lima	6275	3.52
Broadwater	Helena (Lewis & Clark)	3828	9.50
Deerlodge	Lima (Beaverhead)	6275	3.52
Jefferson	Boulder School	4904	8.11
Lewis & Clark	Helena	3828	9.50
Meagher	Harlowton (Wheatland)	4160	6.83
Park	Livingston	4490	7.19
Ravalli	Darby	3880	7.41
	Hamilton	3529	7.67

[1] If more than one weather station representative of agricultural zones occurs in a county the irrigation requirements are averaged. If there is no station in the county a nearby weather station of the same climactic zone and similar elevation was used.

Table 40
Montana Crop Irrigation Requirements
Estimated Seasonal Consumptive Use, SCS TR-21 Method
By County[1]
Winter Wheat (Spring Planting)

County	Weather Station	Elevation	Net Irrigation/in.
Beaverhead	Dillon	5216	6.42
Broadwater	Helena (Lewis & Clark)	3828	6.69
Deerlodge	-	-	-
Jefferson	-	-	-
Lewis & Clark	Helena	3828	6.69
Meagher	-	-	-
Park	Livingston	4490	4.43
Ravalli	Hamilton	3529	4.70

[1] If more than one weather station representative of agricultural zones occurs in a county the irrigation requirements are averaged. If there is no station in the county a nearby weather station of the same climactic zone and similar elevation was used.

Table 41
Average Acre/Foot Irrigation Water Values
By System Efficiency
Alfalfa Hay
Flood Irrigation

	Short Run Values			Long Run Values		
	Conveyance Efficiency					
County	25%	50%	75%	25%	50%	75%
Beaverhead	16.10	32.21	48.31	15.58	31.16	46.74
Broadwater	11.43	22.85	34.28	11.07	22.14	33.22
Deerlodge	14.68	29.35	44.03	13.96	27.93	41.89
Jefferson	11.41	22.81	34.22	10.70	21.79	32.69
Lewis & Clark	9.23	18.45	27.68	8.87	17.75	26.62
Meagher	9.24	18.48	27.72	8.71	17.43	26.14
Park	5.42	10.84	16.26	5.01	10.02	15.03
Ravalli	9.69	19.37	29.06	8.31	18.62	27.93

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 42
Average Acre/Foot Irrigation Water Values
By System Efficiency
Alfalfa Hay
Sidewheel Sprinkler Irrigation

County	Short Run Values			Long Run Values		
	Conveyance Efficiency					
	25%	50%	75%	25%	50%	75%
Beaverhead	19.77	39.54	59.30	16.35	32.71	49.06
Broadwater	12.94	25.88	38.81	10.64	21.28	31.92
Deerlodge	18.73	37.46	56.18	14.09	28.18	42.27
Jefferson	13.59	24.17	40.76	10.28	20.56	30.84
Lewis & Clark	10.08	20.16	30.24	7.78	15.57	23.35
Meagher	10.85	21.70	32.55	7.43	14.85	22.28
Park	5.38	10.77	16.15	2.71	5.82	8.13
Ravalli	10.77	21.54	32.32	8.33	16.66	24.99

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 43
Average Acre/Foot Irrigation Water Values
By System Efficiency
Alfalfa Hay
Center Pivot Sprinkler Irrigation

	Short Run Values			Long Run Values		
	Conveyance Efficiency					
County	25%	50%	75%	25%	50%	75%
Beaverhead	18.50	37.00	55.50	13.72	27.44	41.16
Broadwater	12.08	24.17	36.25	8.87	17.74	26.61
Deerlodge	17.01	34.01	51.02	10.51	21.02	31.53
Jefferson	12.36	24.72	37.08	7.73	15.46	23.19
Lewis & Clark	9.23	18.45	27.68	6.01	12.02	18.04
Meagher	9.58	19.16	28.73	4.78	9.57	14.35
Park	4.39	8.78	13.17	0.64	1.29	1.93
Ravalli	9.87	19.73	29.60	6.45	12.89	19.34

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 44
Average Acre/Foot Irrigation Water Values
By System Efficiency
Barley
Flood Irrigation

County	Short Run Values 25%	50%	75%	Long Run Values 25%	50%	75%
	Conveyance Efficiency					
Beaverhead	14.81	29.61	44.42	13.86	27.73	41.59
Broadwater	10.45	20.89	31.34	9.83	19.67	29.50
Deerlodge	28.58	57.16	85.74	26.93	53.85	80.78
Jefferson	10.21	20.42	30.63	9.49	18.99	28.48
Lewis & Clark	8.21	16.43	24.64	7.60	15.20	22.80
Meagher	10.57	21.14	31.72	9.72	19.44	29.16
Park	8.81	17.61	26.42	8.00	16.00	23.99
Ravalli	12.80	25.59	38.39	12.03	24.05	36.08

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 45
Average Acre/Foot Irrigation Water Values
By System Efficiency
Barley
Sidewheel Sprinkler Irrigation

	Short Run Values			Long Run Values		
	Conveyance Efficiency					
County	25%	50%	75%	25%	50%	75%
Beaverhead	16.73	33.46	50.20	10.61	21.21	31.82
Broadwater	10.73	21.47	32.20	6.76	13.51	20.27
Deerlodge	35.34	70.67	106.01	24.60	49.19	73.79
Jefferson	10.53	21.07	31.60	5.87	11.75	17.62
Lewis & Clark	7.83	15.67	23.50	3.85	7.71	11.56
Meagher	11.14	22.27	33.41	5.60	11.20	16.81
Park	8.80	17.60	26.40	3.54	7.08	10.62
Ravalli	13.95	27.90	41.85	8.94	17.87	26.81

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

- Sidewheel 65%
- Handline 65%
- Center Pivot 65%
- Graded Border (flood) ... 50%
- Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 46
Average Acre/Foot Irrigation Water Values
By System Efficiency
Barley
Center Pivot Sprinkler Irrigation

	Short Run Values			Long Run Values		
	Conveyance Efficiency					
County	25%	50%	75%	25%	50%	75%
Beaverhead	14.46	28.91	43.37	5.88	11.76	17.64
Broadwater	9.26	18.51	27.77	3.69	7.37	11.06
Deerlodge	31.35	62.70	94.04	16.31	32.63	48.94
Jefferson	8.80	17.61	26.41	2.28	4.55	6.83
Lewis & Clark	6.36	12.71	19.07	0.78	1.57	2.35
Meagher	9.08	18.16	27.24	1.33	2.67	4.00
Park	6.85	13.69	20.54	-0.51	-1.03	-1.54
Ravalli	12.09	24.18	36.26	5.07	10.14	15.21

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 47
Average Acre/Foot Irrigation Water Values
By System Efficiency
Oats
Flood Irrigation

County	Short Run Values 25%	50%	75%	Long Run Values 25%	50%	75%
	Conveyance Efficiency					
Beaverhead	--	--	--	--	--	--
Broadwater	10.28	20.55	30.83	9.66	19.33	28.99
Deerlodge	--	--	--	--	--	--
Jefferson	11.05	22.09	33.14	10.33	20.66	30.98
Lewis & Clark	8.69	17.38	26.08	8.08	16.16	24.24
Meagher	7.61	15.21	22.82	6.75	13.51	20.26
Park	8.96	17.92	26.87	8.15	16.30	24.45
Ravalli	13.74	27.48	41.22	12.97	25.94	38.90

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 48
Average Acre/Foot Irrigation Water Values
By System Efficiency
Oats
Sidewheel Sprinkler Irrigation

County	Short Run Values 25%	50%	75%	Long Run Values 25%	50%	75%
	Conveyance Efficiency					
Beaverhead	--	--	--	--	--	--
Broadwater	10.51	21.03	31.54	6.54	13.07	19.61
Deerlodge	--	--	--	--	--	--
Jefferson	11.62	23.24	34.86	6.96	13.92	20.87
Lewis & Clark	8.46	16.91	25.37	4.48	8.95	13.43
Meagher	7.28	14.56	21.84	1.75	3.49	5.24
Park	9.00	17.99	26.99	3.74	7.48	11.21
Ravalli	15.17	30.35	45.52	10.16	20.32	30.48

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

- Sidewheel 65%
- Handline 65%
- Center Pivot 65%
- Graded Border (flood) ... 50%
- Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 49
Average Acre/Foot Irrigation Water Values
By System Efficiency
Oats
Center Pivot Sprinkler Irrigation

County	Short Run Values 25%	50%	75%	Long Run Values 25%	50%	75%
	Conveyance Efficiency					
Beaverhead	--	--	--	--	--	--
Broadwater	9.04	18.07	27.11	3.47	6.93	10.40
Deerlodge	--	--	--	--	--	--
Jefferson	9.89	19.78	29.66	3.36	6.72	10.09
Lewis & Clark	6.98	13.95	20.93	1.41	2.81	4.22
Meagher	5.23	10.45	15.68	-2.52	-5.05	-7.57
Park	7.04	14.09	21.13	-0.32	-0.64	-0.95
Ravalli	13.31	26.62	39.94	6.29	12.59	18.88

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 50
Average Acre/Foot Irrigation Water Values
By System Efficiency
Other Hays
Flood Irrigation

County	Short Run Values 25%	50%	75%	Long Run Values 25%	50%	75%
	Conveyance Efficiency					
Beaverhead	2.18	4.36	6.54	1.60	3.21	4.81
Broadwater	2.29	4.57	6.86	1.87	3.73	5.60
Deerlodge	-	-	-	-	-	-
Jefferson	1.42	2.85	4.27	.89	1.75	2.62
Lewis & Clark	1.53	3.07	4.60	1.11	2.22	3.33
Meagher	1.00	2.01	3.01	.46	.92	1.38
Park	2.23	4.45	6.68	1.76	3.53	5.29
Ravalli	4.98	9.95	14.93	4.53	9.07	13.60

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 51
Average Acre/Foot Irrigation Water Values
By System Efficiency
Other Hays
Sidewheel Sprinkler Irrigation

	Short Run Values			Long Run Values		
	Conveyance Efficiency					
County	25%	50%	75%	25%	50%	75%
Beaverhead	1.89	3.78	5.67	-1.86	-3.72	-5.57
Broadwater	1.35	2.71	4.06	-1.39	-2.77	-4.16
Deerlodge	-	-	-	-	-	-
Jefferson	0.78	1.57	2.35	-2.78	-5.57	-8.35
Lewis & Clark	0.37	0.75	1.12	-2.37	-4.73	-7.10
Meagher	0.21	0.43	0.64	-3.32	-6.64	-9.95
Park	1.45	2.89	4.34	-1.55	-3.10	-4.65
Ravalli	4.94	9.95	14.93	2.06	4.13	6.19

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 52
Average Acre/Foot Irrigation Water Values
By System Efficiency
Other Hays
Center Pivot Sprinkler Irrigation

County	Short Run Values 25%	50%	75%	Long Run Values 25%	50%	75%
	Conveyance Efficiency					
Beaverhead	0.50	1.00	1.50	-4.75	-9.50	-14.25
Broadwater	0.34	0.67	1.01	-3.50	-7.00	-10.50
Deerlodge	-	-	-	-	-	-
Jefferson	-0.54	-1.08	-1.62	-5.54	-11.08	-16.62
Lewis & Clark	-0.64	-1.29	-1.93	-4.48	-8.96	-13.45
Meagher	-1.10	-2.19	-3.29	-6.04	-12.09	-18.13
Park	0.33	0.67	1.00	-3.86	-7.73	-11.59
Ravalli	3.87	7.75	11.62	-0.16	-0.31	-0.47

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 53
Average Acre/Foot Irrigation Water Values
By System Efficiency
Spring Wheat
Flood Irrigation

County	Short Run Values Conveyance Efficiency 25%	50%	75%	Long Run Values 25%	50%	75%
Beaverhead	25.63	51.26	76.90	24.69	49.38	74.07
Broadwater	17.71	35.42	53.12	17.10	34.19	51.29
Deerlodge	15.82	31.63	47.45	14.16	28.33	42.49
Jefferson	6.22	12.44	18.66	5.50	11.00	16.51
Lewis & Clark	14.62	29.24	43.87	14.01	28.02	42.03
Meagher	6.31	12.62	18.93	5.46	10.92	16.38
Park	5.63	11.26	16.89	4.82	9.65	14.47
Ravalli	24.95	49.90	74.85	24.18	48.36	72.53

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 54
Average Acre/Foot Irrigation Water Values
By System Efficiency
Spring Wheat
Sidewheel Sprinkler Irrigation

	Short Run Values			Long Run Values		
	Conveyance Efficiency					
County	25%	50%	75%	25%	50%	75%
Beaverhead	30.80	61.61	92.41	24.68	49.36	74.05
Broadwater	20.18	40.35	60.53	16.20	32.39	48.59
Deerlodge	18.75	37.49	56.24	8.01	16.01	24.02
Jefferson	5.34	10.69	16.03	0.68	1.37	2.05
Lewis & Clark	16.16	23.33	48.49	12.19	24.37	36.56
Meagher	5.60	11.20	16.79	0.06	0.13	0.19
Park	4.67	9.34	14.01	-0.59	-1.17	-1.76
Ravalli	29.75	59.50	89.24	24.73	49.47	74.24

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)

Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 55
Average Acre/Foot Irrigation Water Values
By System Efficiency
Spring Wheat
Center Pivot Sprinkler Irrigation

County	Short Run Values			Long Run Values		
	Conveyance Efficiency					
	25%	50%	75%	25%	50%	75%
Beaverhead	28.53	57.06	85.59	19.96	39.92	59.88
Broadwater	18.70	37.40	56.10	13.13	26.25	39.38
Deerlodge	14.76	29.51	44.27	-0.28	-0.56	-0.83
Jefferson	3.61	7.23	10.84	-2.91	-5.82	-8.74
Lewis & Clark	14.69	29.37	44.06	9.12	18.23	27.35
Meagher	3.54	7.08	10.63	-4.21	-8.41	-12.62
Park	2.72	5.44	8.16	-4.64	-9.28	-13.93
Ravalli	27.89	55.77	83.66	20.87	41.73	62.60

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)

Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 56
Average Acre/Foot Irrigation Water Values
By System Efficiency
Winter Wheat
Flood Irrigation

County	Short Run Values 25%	50%	75%	Long Run Values 25%	50%	75%
	Conveyance Efficiency					
Beaverhead	4.62	9.23	13.85	3.71	7.42	11.13
Broadwater	16.62	33.24	49.86	15.75	31.50	47.26
Deerlodge	-	-	-	-	-	-
Jefferson	-	-	-	-	-	-
Lewis & Clark	-5.85	-11.69	-17.54	-6.72	-13.43	-20.15
Meagher	-	-	-	-	-	-
Park	17.00	33.99	50.99	15.68	31.36	47.05
Ravalli	1.83	3.66	5.49	.59	1.18	1.78

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 57
Average Acre/Foot Irrigation Water Values
By System Efficiency
Winter Wheat
Sidewheel Sprinkler Irrigation

	Short Run Values			Long Run Values		
	Conveyance Efficiency					
County	25%	50%	75%	25%	50%	75%
Beaverhead	3.45	6.89	10.34	-2.44	-4.88	-7.33
Broadwater	19.02	38.04	57.05	13.37	26.74	40.10
Deerlodge	-	-	-	-	-	-
Jefferson	-	-	-	-	-	-
Lewis & Clark	-10.19	-10.38	-30.57	-15.84	-31.68	-47.52
Meagher	-	-	-	-	-	-
Park	19.94	39.89	59.83	11.41	22.82	34.23
Ravalli	0.15	0.31	0.46	-7.89	-15.78	-23.67

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Table 58
Average Acre/Foot Irrigation Water Values
By System Efficiency
Winter Wheat
Center Pivot Sprinkler Irrigation

	Short Run Values			Long Run Values		
	Conveyance Efficiency					
County	25%	50%	75%	25%	50%	75%
Beaverhead	1.26	2.52	3.78	-6.98	-13.97	-20.95
Broadwater	16.92	33.84	50.76	9.01	18.02	27.03
Deerlodge	-	-	-	-	-	-
Jefferson	-	-	-	-	-	-
Lewis & Clark	-12.29	-24.58	-36.87	-20.20	-40.40	-60.60
Meagher	-	-	-	-	-	-
Park	16.77	33.55	50.32	4.83	9.65	14.48
Ravalli	-2.83	-5.67	-8.50	-14.10	-28.19	-42.29

Note: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Crop-water Production Function Water Valuation

As was discussed in Section 4, the production function approach to agricultural water valuation is based on the profit-maximizing model of the firm. The basic result of this model is that the business will be willing to pay a price for inputs to the production process which is equal to the contribution of that input to production. The contribution of an input is measured by multiplying that input's marginal product by the market price for the output (Equation 1, Section 4). In applying this straightforward approach to the problem of agricultural water valuation two pieces of information were necessary: 1) marginal product estimates for agricultural water and 2) price information on agricultural commodities.

Marginal product of water estimates were drawn from the economics literature. Crop-water production function experiments (which yield these estimated marginal products) are closely monitored agricultural studies in which varying amounts of water are applied to a crop in order to determine how crop yield varies with water application. Of the crops studied in this manner only alfalfa was compatible with the crops of interest to DFWP. Alfalfa does, however, constitute 33% of the cropland in the 8 counties of interest to DFWP and thus, at the least, provides a measure of validation for other valuation methodologies.

In an effort to minimize the effect of differences between the soils and climactic conditions of the experimental alfalfa crops and Montana crops production, function estimates for several different studies were averaged. Specifically, two separate groups of alfalfa crop-water production functions were averaged in order to provide a range of marginal product estimates. The first group of seven studies, which was surveyed by Sammis (1981) included studies in North Dakota, New Mexico, Nebraska and Nevada. The estimated functions were all linear in specification and of the form: Yield = Constant + MP (Evapotranspiration). The second group consisted of four studies surveyed by DNRC (1989). These studies were conducted in Idaho, North Dakota, Nevada and Utah and were also all linear in specification. The fact that all of these estimated relationships are linear in specification simplifies their interpretation in regards to marginal water values. A linear form necessarily implies that the marginal product of the water input will be the same throughout the entire range of water input reductions. Therefore, whether we are investigating a 10% or 100% decrease in irrigation water applied to an alfalfa field, the per acre/foot value of the water will be the same.

Tables 59 and 60 show the calculation of the acre foot values for water used to irrigate alfalfa. These tables provide water value estimates for a broad range of conveyance and distribution efficiencies, following Equations 1 and 3 in Section 4. As was

done in the comparison of irrigated and nonirrigated method of valuation, the average alfalfa price paid to farmers for the years 1987, 1988 and 1989 was used in the value calculations. It can be seen that there is a broad range for the value estimates. As was discussed in Section 4, this range is directly driven by the varying efficiencies of the conveyance and application systems. For this reason the use of acre foot values for water can be misleading and a more stable measure of value can be found by tying a particular water right to a specific land base. Tables 61 and 62 show the per acre values for water used to irrigate alfalfa in the counties of interest to DFWP, following equation 2 (where $A_j = 1$). Computation of these tables require an assumption of how much water is used in a given county. For purposes of illustration we used the SCS calculated <u>maximum possible</u> net irrigation (maximum ET). Accordingly, these tables are maximum possible values. One would need to know actual irrigation water use at the site to use this method correctly in a given case.

As was done in the comparison methodology above, if an SCS estimate of net irrigation needs in a county was not available an irrigation estimate from a nearby weather station of similar climactic zone and elevation was used in proxy. It is important to note that the per acre values in these tables are "at-the-crop" values in the sense that they are per unit of land. Given the total acres in production it is straightforward to then compute a total lease value using acres times unit acre price from Table 61 (following Equation 3, Section 4). Again, The key assumption is that the crop in a given case is actually supplied with the SCS maximum possible net irrigation requirements listed in Table 61. This may not be true on a given site if, for example, there is limited water and, especially for sandy soils, conveyance is by unlined ditch and application is by flood irrigation.

Table 59

Marginal Values of Irrigation Water
For Alfalfa Hay
Montana DNRC Production Functions

MPP	Crop Price	Conveyance Eff.	Field Eff.	Dollar per AC/FT Value
.19	65.19	.25	.50	18.58
.19	65.19	.25	.65	24.15
.19	65.19	.50	.50	37.16
.19	65.19	.50	.65	48.31
.19	65.19	.75	.50	55.74
.19	65.19	.75	.65	72.46

Note 1: The crop Price for Alfalfa is a three year average for 1986, 1987 and 1988.

Note 2: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Note 3: The Marginal Physical Productivity (MPP) of water was derived from Montana DNRC (1989) average of four crop-water production function studies. The average function was Yield = .63 + .19 ET. ET is in inches. The MPP is the change in units of production (tons in this example) for a one unit change in a variable input (in this case one additional acre-inch of water).

Table 60

Marginal Values of Irrigation Water
For Alfalfa Hay
Sammis Production Functions

MPP	Crop Price	Conveyance Eff.	Field Eff.	AC/FT Value
.159	65.19	.25	.50	15.54
.159	65.19	.25	.65	20.21
.159	65.19	.50	.50	31.09
.159	65.19	.50	.65	40.42
.159	65.19	.75	.50	46.64
.159	65.19	.75	.65	60.64

Note 1: The crop Price for Alfalfa is a three year average for 1986, 1987 and 1988.

Note 2: Field, or application, efficiencies for well maintained and managed systems are approximately:

Sidewheel 65%
Handline 65%
Center Pivot 65%
Graded Border (flood) ... 50%
Graded Furrow (flood) ... 50%

(Montana DNRC Efficiency Figures)
Conveyance efficiencies vary greatly. SCS (Montana Irrigation Manual) notes that conveyance efficiencies as low as 25% are not uncommon in Montana.

Note 3: The Marginal Physical Productivity (MPP) of water was derived from Sammis (1981) average of seven crop-water production function studies. The average function was
Yield = x + .159 ET. ET is in inches .

Table 61
Maximum Possible Per Acre Values for Water
Irrigated Alfalfa
Montana DNRC Production Functions

County	AC/FT Value	Maximum Possible Irr. Require.	Value Per Acre
Beaverhead	148.63	11.07	137.11
Broadwater	148.63	16.46	203.87
Deerlodge	148.63	8.15	100.94
Jefferson	148.63	11.43	141.57
Lewis & Clark	148.63	16.46	203.87
Meagher	148.63	11.04	136.74
Park	148.63	14.13	175.01
Ravalli	148.63	15.47	191.67

Note: Acre/Foot value is an "at-the-crop" value for the water. That is, it assumes a 100% efficiency of the conveyance and distribution systems. The values per acre are independent of the efficiency assumption, but do require the assumption that the irrigation requirements are met.

Table 62
Maximum Possible Per Acre Values for Water Irrigated Alfalfa
Sammis' Production Functions

County	AC/FT Value	Maximum Possible Irr. Require.	Value Per Acre
Beaverhead	124.38	11.07	114.74
Broadwater	124.38	16.46	170.61
Deerlodge	124.38	8.15	84.47
Jefferson	124.38	11.43	118.47
Lewis & Clark	124.38	16.46	170.61
Meagher	124.38	11.04	114.43
Park	124.38	14.13	146.46
Ravalli	124.38	15.47	160.34

Note: Acre/Foot value is an "at-the-crop" value for the water. That is, it assumes a 100% efficiency of the conveyance and distribution systems. The values per acre are independent of the efficiency assumption, but do require the assumption that the irrigation requirements are met.

Comparison of County-level and Crop-water Production Function Results

It is interesting to look at the results of the two general methods of valuing agricultural water and attempt to explain any differences between them. Table 63 shows a comparison of the short run per acre water value estimates for alfalfa from Table 23 and the per acre water value estimates from Table 63. In all counties, not surprisingly, the maximum possible production function water values are higher than the county-level values. In several cases (Park, Ravalli, and Lewis and Clark counties) the production function values are significantly higher. This primarily indicates that in actuality crops in most counties are not being supplied with the maximum amount of water in the root zone when needed. Differences between maximum and actual water applications are not the only reason experiment station yields are higher than county averages. There are also wide differences in harvesting practices, fertilizing, weed control, soil, fall and winter grazing of hay fields, etc. The MPP of an acre foot will be higher for the better producers. Assuming that maximum yields are comparable to experiment station yields could give a very rough handle on the range of yields needed to give observed average yields. This and related explanations are discussed below.

One explanation lies in the basic differences between the county-level method of water valuation and the production function method. There is a fundamental difference in the data upon which the two types of estimates are based. The county-level data consists of average acreages, and average yields within counties. The production function data, on the other hand, is based on a small number of very closely controlled agricultural experiments. As a result of this difference, crops raised in the controlled production function settings receive a level of attention to input needs that is impractical in the general farming setting.

One of the key assumptions of the county-level comparison method of water valuation is that the crops are receiving enough water to meet their maximum evapotranspiration needs. While this may be a reasonable assumption in the case of the crop-water production function experiments (where water needs and soil moisture are very closely monitored) in the day-to-day practice of Montana farmers, particularly those using flood irrigation, it may not be so reasonable. In an effort to further explain the differences between the county-level and production function estimates Table 64 shows the amount of net irrigation application that the net difference in crop yields of irrigated and nonirrigated lands implies. This implied net irrigation amount was calculated by dividing the tons per acre net difference in yield from Table 17 by the DNRC average MPP of water to alfalfa production (.19). The implied actual rainfall plus soil moisture

amounts were calculated by dividing the average nonirrigated yield (tons per acre) by .19.

A comparison of the implied actual alfalfa water use and the SCS calculated potential water use (both detailed in Table 64) is shown in Table 65. This comparison is presented as ratios of the implied actual amounts to the SCS potential ET amounts. Note that actual observed production on nonirrigated lands and the production implied by SCS rainfall and soil moisture plus use of the production function method are very similar (the ratios in column 1 of Table 65 are close to 1). This indicates a consistency between the methods and validates the use of the production function relationship. Given this, what the second column in Table 65 illustrates is that in most counties, maximum possible ET is not being met by net irrigation, but rather some fraction.

Only in the cases of Beaverhead and Deer Lodge counties are the overall ratios quite close to 1.0. In both of these cases the weather station at Lima was used to determine maximum ET requirements (in the case of Beaverhead county Lima data was averaged with Dillon data and in Deer Lodge county Lima data was used as proxy in the absence of any Deer Lodge county weather stations). At an altitude of over 6200 feet, the Lima station probably underestimates the actual ET requirements for Deer Lodge and Beaverhead counties somewhat. There are two effects of this probable understatement; 1) the per acre value of irrigation water in these counties is overstated and 2) Table 65 may show that irrigated alfalfa in these counties is receiving a higher percentage of it's potential ET needs than is actually true. In general Table 65 shows that in most counties (Park, Meagher and Lewis and Clark in particular) the irrigated alfalfa crops are not reaching their potential ET levels. This of course assumes that all other inputs into crop production (soil type, fertilizer, etc.) are constant across sites within counties and thus, differences in yields are driven by varying applications of water.

Obviously in order to apply the production function approach, one needs to know the actual water available to the crop. Merely assuming maximum irrigation needs are met is not valid. We emphasize again that the values in Tables 61 and 62 are maximum possible values.

To summarize, there is some uncertainty about the actual amount of irrigation water available to crops on average by county. This implies that for the production function approach the values per acre foot at the crop (Tables 59 and 60) are fine to use if you know the actual acre foot use at the site. In general, however, it's better to use the county-level average based value per acre (Tables 23 to 34) to estimate total lease values.

To get acre foot values of water from the county average method, it's necessary to assume how much water is actually available to the plant. For purposes of Tables 41-58, we assumed that the SCS maximum possible was available to the crops. Since we know from the comparison in Table 65 that this is probably not true in most counties, The acre foot values in Tables 41-58 may understate true acre foot values. This is because we are dividing actual yields and returns by an assumed amount of water - with the latter likely overstated. The basic problem is the lack of county average hydrologic information.

The comparison of the two general methods of water value estimation leads us to the following conclusions.

1) The county-level comparison method is best for estimating the per acre value of a water right. This method will return the average upper limit to the agricultural per acre value of the water. The county-level comparison method is appropriate where doubt remains as to whether the cropland of interest receives the potential ET level of moisture calculated by SCS.

2) The production function method of water value estimation is appropriate where it is known that the cropland of interest receives all the water it can use in a growing season. In this case the value per acre will not be overstated, as it will be if the crop water use falls below the potential ET level. Alternatively, the production function approach gives a good estimate of value of water per acre foot if one happens to have information on site specific hydrology. In all cases the production function method can only be used for calculation of per acre/foot values for alfalfa.

Table 63

Comparison of Per Acre Water Values of
Production Function and County-level Comparison Methods
Alfalfa

County	Maximum Possible Production Function Per Acre Value	Actual County-level Per Acre Value
Beaverhead	137	119
Broadwater	204	125
Deer Lodge	101	80
Jefferson	142	87
Lewis and Clark	204	101
Meagher	134	68
Park	175	51
Ravalli	192	100

Note: The production function values are based on the use of DNRC's average functions. DNRC's functions were used since they were more representative of climactic areas similar to Montana than were Sammis' functions.

The county-level water values are based on flood irrigation values from Table 23.

Table 64

Implied Actual Water Use v. SCS Maximum Potential
Evapotranspiration
Alfalfa Hay

Count	Actual 1980-88 Average Yields (Tons/Acre)			Implied Actual Water Use (in)[4]			Maximum SCS Potential ET (in)[5]		
	No irr.[1]	Irr.[2]	Diff.[3]	R+SM	Irr.	Total	R+SM	Irr.[6]	Total
Beaverhead	1.18	3.31	2.13	6.21	11.21	17.42	6.89	11.07	21.12
Broadwater	1.29	3.52	2.23	6.79	11.74	18.53	7.31	16.46	23.77
Deer Lodge	1.31	2.84	1.53*	6.89	8.05	14.94	6.64	8.15	15.15
Jefferson	1.49	3.13	1.64	7.84	8.63	16.47	7.23	11.43	18.66
Lewis & CK	1.24	3.10	1.86	6.53	9.78	16.31	7.31	16.46	23.77
Meagher	1.26	2.61	1.35	6.63	7.10	13.73	9.67	11.04	20.72
Park	1.59	2.68	1.09	8.37	5.74	14.11	9.91	14.13	24.04
Ravalli	1.70	3.54	1.84	8.94	9.68	18.62	7.70	15.48	23.18

[1] From Table 6
[2] From Table 5
[3] From Table 17
[4] Based on DNRC average production function: Yield (Tons/acre) = x + .19 (Inches water).
[5] Source: SCS Montana Irrigation Guide
[6] From Table 35
R+SM = Net rainfall in a normal year plus usable soil moisture.

Table 65

Ratios of Implied Actual Water Use to Maximum SCS Potential ET
Alfalfa Hay

County	R+SM	Net Irrigation	Total ET
Beaverhead	.94	1.01	.96
Broadwater	.93	.71	.78
Deer Lodge	1.04	.99	.99
Jefferson	1.08	.76	.88
Lewis & Clark	.89	.59	.69
Meagher	.69*	.64	.66
Park	.85	.41	.59
Ravalli	1.06	.63	.80

Note: The values are the implied actual water use values from Table 64 divided by the SCS maximum potential water use (ET) values from the same table.

* Note use of Wheatland County weather station (given the lack of weather data for Meagher County) may have caused this substantial deviation from a ratio of 1.00.

Note that rain plus soil moisture (R+SM) is the water input basis for nonirrigated yields, while net irrigation water input is the basis for the additional yields (over nonirrigated lands) on irrigated lands. Total water use explains total yield on irrigated lands.

6. RESULTS OF SITE SPECIFIC ESTIMATES OF VALUE OF IRRIGATION WATER ON SWAMP CREEK

Introduction: Extent of the Market and Type of Change

The Swamp creek water right which is currently being investigated for possible leasing by DFWP is owned by Fred Hirschy's wife, Lynn, of Wisdom, Montana. This right is the senior decreed right on Swamp creek and is diverted at the creek's lower-most diversion. This diversion is located approximately 2 1/2 miles above the mouth of the creek and has been used to irrigate about 600 acres of wild hay and pasture. The Hirschy's water right is for 135 miner's inches (or 3.375 cfs) which is diverted between April 1 and October 30 providing a total diverted volume of 1417.5 acre/feet per year.

The proposed Swamp creek lease provides a case of displaced agricultural production in the valuation of agricultural water. The question is at what price Fred Hirschy might lease the water for instream uses to DFWP versus using it to irrigate that land. The market for this water is a limited one with the DFWP lease appearing to be the only feasible alternative water use to continued irrigation. The appropriate method of calculating the minimum value of this right is by estimating the value of the lost pasture grass production which would result from keeping the water instream. This will be done in two ways. First, a value will be calculated based on the Hirschy land's specific production history. This initial water value will be based on estimates of different production levels under varying irrigation scenarios provided by informal discussions with Fred and Jack Hirschy. A second estimate of the value of the Swamp Creek lease will be derived from the comparison of irrigated and nonirrigated wild hay production for Beaverhead county.

Value Based on Site Specific Production History

In a discussion with Mark Josephson, John Duffield and Ernie Harvey on September 23, Fred Hirschy explained his position on the desirability of and alternatives to leasing his water rights on Swamp Creek to DFWP. The current situation is one where the pasture has been only partially irrigated for some time and so production is in decline from earlier full production practices. However, production is still higher than if no irrigation had been undertaken in recent years. In essence Fred Hirschy presented three possible scenarios. One option would be to allow the native grasses to go unirrigated, in which case productivity would drop slightly from present levels. A second option would be to make an investment in improvement of the irrigation system and begin irrigation of the land, in which case productivity would rise for 5 years and then level off at a much higher level than it currently has. The third possible irrigation strategy (and the one he would like to pursue if DFWP goes through with

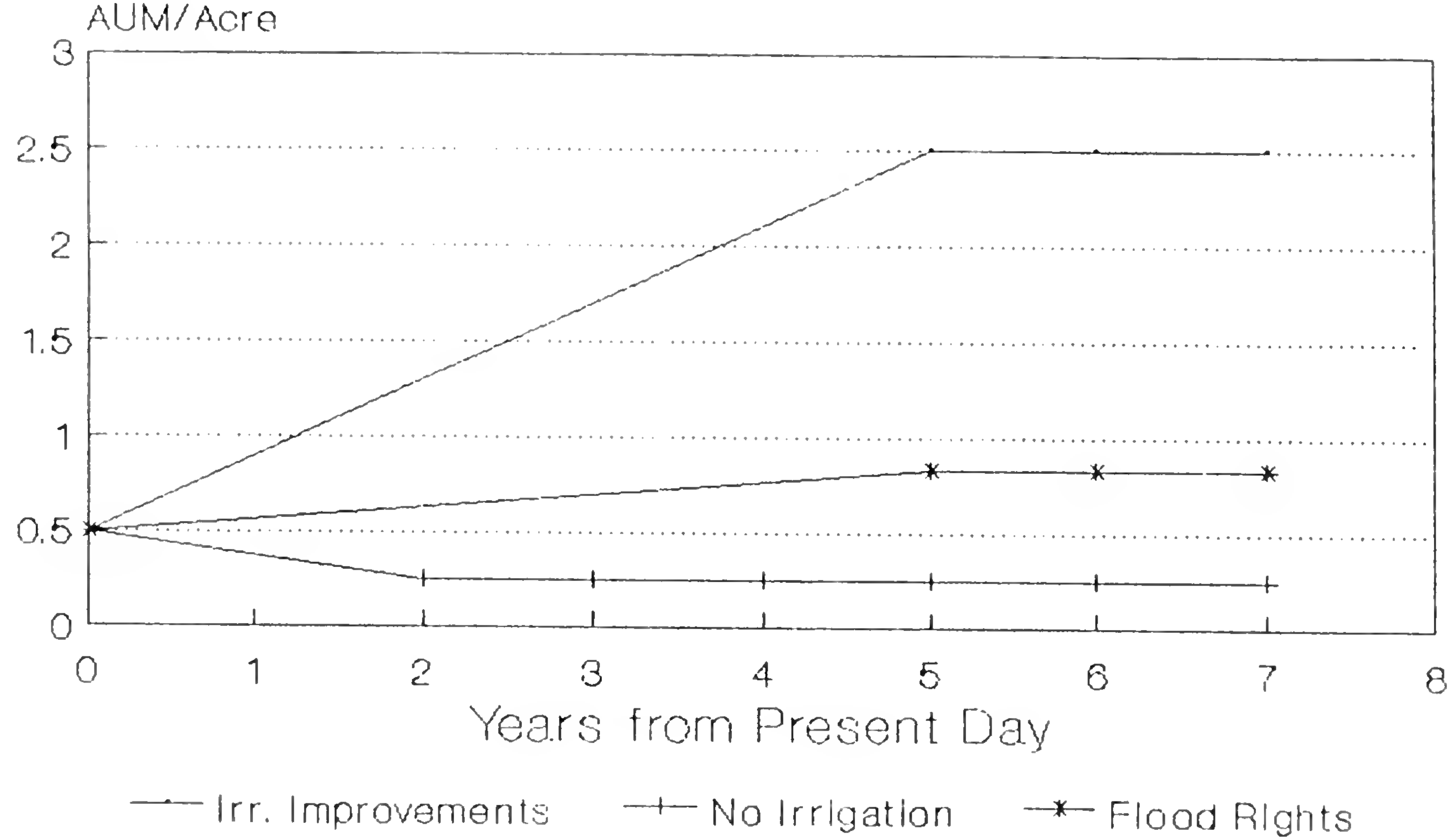
leasing) is to retain flood irrigation rights (there is some question as to whether Montana law would allow this type of lease structure) in which case he must make improvements in the irrigation system (as in the first case) and he expects production to be 1/3 of full irrigation production. These three scenarios are shown graphically in Figure 1. To summarize production by option (and based on the assumed facts listed below), the current situation is one of about .5 AUM/acre. Option 1 is no irrigation or .25 AUM/acre. Option 2 is full irrigation or 2.5 AUM/acre. Option 3 is flood rights or .85 AUM/acre (see Figure 1).

The following information on the Hirschy land was provided by Fred Hirschy in informal discussions. In case of any possible misunderstanding on our part from these limited discussions, it would be wise if formal negotiations proceed to perhaps first validate (through further discussions with Fred or by providing him with this report for review) that the following are agreed upon facts.

-- Swamp Creek diversion serves approximately 600 acres
-- Cattle graze it for 5 months (mid-May to mid-October)
-- Current production is relatively low (approx. 10 acres per cow/calf pair
-- If investment in an irrigation system was made the irrigated land could sustain 2 acres per pair yield
-- If no irrigation is done production will fall to approximately 20 acres per pair
-- Estimated amortized cost of irrigation improvements plus annual labor costs are $ 3000 per year ($4-$5 per acre)
-- Estimated market value of land as leased pasture is $14 to $18 per AUM
-- Hirschy water right is for 135 miner's inches or 3.375 cfs
-- Hirschy wants the term of the lease to be at a minimum 5 and possibly 10 years.

We have used these assumptions in the following computations. The lower value of the AUM lease price range ($14) was used as this seems more comparable with lease prices in other markets. Given the above information it is possible to construct three operational time lines which calculate net profits from grazing under the three scenarios. Table 66 computes yearly income for each of the three scenarios for the next five years.

Swamp Creek Water Lease
AUM/Acre Yield v. Time



Data Supplied by Fred Hirschy

Table 66
Analysis of Swamp Creek Lost Production Values

Current Conditions (Year 0)
Lease Value of Pasture $14/AUM

	Improvements	No Irr.	Flood Rights
# AUM/Acre/Year	.5	.5	.5
$/Acre/Year	$7	$7	$7
* 600 Acres	$4200	$4200	$4200
- Added irr. costs	0	0	0
Lease Income	$4200	$4200	$4200

Year 1
Lease Value of Pasture $14/AUM

	Improvements	No Irr.	Flood Rights
# AUM/Acre/Year	.75	.375	.60
$/Acre/Year	$10.50	$5.25	$8.40
* 600 Acres	$6300	$3150	$5040
- Added irr. costs	($3000)	0	($3000)
Lease Income	$3300	$3150	$2040

Year 2
Lease Value of Pasture $14/AUM

	Improvements	No Irr.	Flood Rights
# AUM/Acre/Year	1.25	.25	.70
$/Acre/Year	$17.50	$3.50	$9.80
* 600 Acres	$10500	$2100	$5880
- Added irr. costs	($3000)	0	($3000)
Lease Income	$7500	$2100	$2880

Year 3
Lease Value of Pasture $14/AUM

	Improvements	No Irr.	Flood Rights
# AUM/Acre/Year	1.75	.25	.75
$/Acre/Year	$24.50	$3.50	$10.50
* 600 Acres	$14700	$2100	$6300
- Added irr. costs	($3000)	0	($3000)
Lease Income	$ 11700	$2100	$3300

Year 4
Lease Value of Pasture $14/AUM

	Improvements	No Irr.	Flood Rights
# AUM/Acre/Year	2.25	.25	.80
$/Acre/Year	$31.50	$3.50	$11.20
* 600 Acres	$18900	$2100	$6720
- Added irr. costs	($3000)	0	($3000)
Lease Income	$ 15,900	$2100	$ 3720

Year 5
Lease Value of Pasture $14/AUM

	Improvements	No Irr.	Flood Rights
# AUM/Acre/Year	2.50	.25	.833
$/Acre/Year	$35.00	$3.50	$11.66
* 600 Acres	$21000	$2100	$6997
- Added irr. costs	($3000)	0	($3000)
Lease Income	$18,000	$2100	$3997

In order to determine the value of the Swamp creek lease based on it's site specific production history we must compare the outcomes of the possible scenarios outlined above. If the Hirschy's were not to lease their water for instream purposes they would be faced with the decision of whether to let the land go unirrigated, or invest in irrigation improvements and operate it as irrigated pasture. We make the assumption that they would choose the alternative with the highest net return; that is, to invest in the irrigation improvements and fully irrigate it in the future.

Table 67 shows a range of possible lease options and the net present value of the stream of net returns associated with each. The lease options are (A) not lease, (B) lease with flood rights or (C) lease with no irrigation rights. As noted, in this analysis we have chosen to use the lower end of the potential pasture lease prices ($14/AUM) estimated by Fred Hirschy. This figure was chosen based on discussions with local SCS personnel. It should be noted that these estimates are the estimates of lost production over the term of the lease which could be interpreted as the minimum amount that Fred Hirschy (under this set of estimates and assumptions) might be willing to accept for the alternative lease scenarios. Fred Hirschy has, by the way, made it clear that he expects the lost production value to be a small part of the total lease value. (See the discussion in Section 9 on indemnification).

Table 68 shows both the lump sum estimated cost of the Swamp Creek lease under three different production options and two different lease terms and the average year-to-year cost of the same options and terms. The two lease terms are described as follows: 1) a five year lease which begins at the present time, before any improvements are made to the irrigation system on the Hirschy land, 2) a ten year lease which begins at the present time as in scenario 1). The three production options correspond to the three options examined in Table 66: full irrigation (no lease of water), no irrigation and retain flood rights. Figure 1 shows the changes in assumed productivity over the range of these lease scenarios based on the information provided by Fred Hirschy.

The lump sum values for the two lease terms show significant initial benefits to the state associated with securing a lease agreement in the near term, before planned land improvements can be made. Additionally, there are benefits to the state associated with allowing the Hirschys to maintain flood rights and partially irrigate their land. Lease option B (allowing the Hirschys to retain flood rights has an estimated net present value of $34,125 for the five years, or an average year-to-year payment value of $7795, and a net present value of $83,081 for a ten year lease, or $10,551 per year. Lease option C (no irrigation) shows a net present value of $37,693 for it's five

year life, or a year-to-year value of $ 8,610, and a net present value of $93,298 for a ten year lease, or $11,847 per year. For any leases negotiated in the next year or so, the appropriate value is about $7800 per year for a 5 year lease or $10,500 per year for a 10 year lease. As the lease term gets longer (or negotiations are delayed), the foregone opportunity to Fred Hirschy approaches the net foregone full yearly production value of about $14,000 per year for the flood right option. Note that the potential saving to the flood right option is greater if hirschy's production under this option is greater than 1/3 of full irrigation production. This is an important assumption to examine, if possible, through site level hydrological investigations.

Value Based on County Level Historical Data

Direct analysis of the Swamp creek water values using the county level historical data is somewhat problematic as the Hirschys have used their pasture grass acreage as cattle forage rather than a harvested crop. However, by assuming the crop's value as forage is the same as its value as harvested native hay we can make an analysis based on the county level data. It might be noted that yields from well managed pasture are generally higher than corresponding hay yields, particularly for grasses. Accordingly, the estimate we derive below based on county level average yields may be conservative.

It is important when using the county level comparison of irrigated and nonirrigated crop yields to input any site specific data which is available into the calculations. In the case of Swamp Creek, Fred Hirschy has estimated that long term improvements to the ditches and irrigation costs amount to approximately $4.00 per acre/year. This amount was substituted for the $20.00 per acre assumed irrigation cost in Table 69. For the Swamp Creek case the only values of immediate interest are those for flood irrigation. These amounts are shown in **bold** in table 69. As was discussed in Section 5, the best use of the county-level comparison value estimates is as a land based value. That is, the per acre water values should be used in preference

to the per acre foot values. For the Swamp Creek lease the per acre water value (from Table 69) is $30.67. With a total irrigated acreage of 600 acres the total yearly value of the lease would be $ 18,402. This value assumes that the Hirschy land is as productive for wild hays as the average wild hay land in Beaverhead County. This value would be for an irrigated versus non irrigated case and is somewhat larger than, but similar to the estimated yearly value based on Fred Hirschy's expected full production level - $15,900 for the no irrigation option. (The latter is derived from 18,000 less 2100 for years after year 5 in Table 67). This shows some consistency and validation between the several approaches.

The county-level comparison method of valuation suggests that the Hirschy's water is worth $12.98 per acre/foot at the point of diversion, given the estimated total diversion of 1417.5 acre feet. Site specific hydrologic investigations would, of course, refine these estimates.

Table 69
ANALYSIS OF SWAMP CREEK WATER VALUATION USING COUNTY LEVEL HISTORICAL DATA

OTHER HAYS

	BEAVERHEAD COUNTY
YIELD DIFFERENCE	0.60
CROP PRICE	57.78
GROSS VALUE DIFFERENCE	34.67
S.R. FLOOD COSTS	4.00
NET IRRIGATION REQU.	10.09
S.R. VALUE/ACRE FLOOD	30.67
L.R. FLOOD COSTS	3.88
L.R. VALUE/ACRE FLOOD	27.79

Per acre short run value of Swamp Creek water right		$ 30.67
Number of acres	x	600
Total annual value of Lease		$ 18,402

Note: S.R. indicates short run costs and values and L.R. indicates long run costs and values.

Comparison and Recommendation

Table 70 shows a comparison of the various estimates. The county-level comparison method assumes that the land is producing at the Beaverhead County average production level. This method estimates that the Swamp Creek water right would be worth $30.67 per acre. This translates into a per year lease cost of $18,402. However, we know that the Hirschy land is currently producing below it's potential and only after approximately five years of improvements will it be producing at it's capacity. If we invoke the assumption into the site specific method that the land at the beginning of the lease is producing at it's maximum, the per acre value of water for the site specific method is $26.50 (calculated as full production returns of $18,000 minus nonirrigated production returns of $2100, or $15,900 divided by 600 acres). This value is lower but quite similar to the per acre estimate of the comparison method of $30.67. One reason for this difference may be a higher per acre production of average Beaverhead County wild hay crops than what the Hirschys expect from their fields.

More realistically, value can be based on actual and expected production. The site method allowing the Hirschys to retain flood rights estimates the water to be worth $12.99 per acre or $7,795 per year. The site method which assumes all irrigation stops values the water at $14.35 per acre or a total lease cost of $8,610 per year. Assuming an irrigated land base of 600 acres and a total flow of 1417.5 acre feet, the acre/foot water value for the site specific method is $5.50 for the flood rights option and $6.07 for the no irrigation option.

The county-level comparison method estimates in this case validate the general upper range to possible value based on production loss. It should be noted that the estimates of both methods are sensitive to assumptions about the price of the foregone commodities; in the case of the county method, wild hay, and for the site method, lease value per AUM. Additionally, both estimates are sensitive to the level of irrigation costs (assumed to be $4.00 per acre). If the default cost of $20.00 per acre were used instead, the values for both methods would be substantially lower. Careful attention should be directed at compiling the best revenue and cost estimates possible when applying these methods as accurate estimation of water values for a specific site depends on using the most complete and accurate information available.

We conclude that the site specific estimate here, based on current actual or expected foregone production (Table 70), is the best estimate of foregone production value at about $7,800 to $8,600 per year for a 5 year lease or $10,500 to $12,000 per year for a 10 year lease term. Additionally, we conclude that the option of allowing the Hirschys to retain flood rights on their

property and thus maintain a level of irrigated production should be examined. This option would present a savings to the state.

Table 70
Comparison of County and Site Specific Value Estimates
Swamp Creek Lease (Five Year Term)

	Full Production	
	County Method (No Irrigation)	Site Method (No Irrigation)
Water Value per Acre	$30.67	$26.50
Total per year lease cost	$18,402	$15,900
Acre/Foot Value	$12.98	$11.22

	Current Actual and Expected Production (Site Method)	
	Flood Rights	No Irrigation
Water Value per Acre	$12.99	$14.35
Total per year lease cost	$7,795	$8,610
Acre/Foot Value	$5.50	$6.07

7. Results of Site Specific Estimates of Value of Irrigation Water on Big Creek

Introduction: Extent of the Market and Type of Change

The value estimates in the case of Swamp Creek are derived using both the county historical productivity figures and the site specific production history. The Swamp creek example is a case of water valuation based on the foregone value of agricultural production. Big Creek, by contrast, is a case where the potential supply of water will be augmented by investment in a more efficient irrigation system. The value of the water in this case will be dominated by the supply side of the market - that is, by the cost of the investment in the irrigation system.

The market for water on Big Creek is a spatially constrained one. Nine people acting as one company desire to lease surplus agricultural water to the state for instream uses. The market for water on Big Creek, therefore, consists of a single buyer and a single seller. The market price in this instance is indeterminate and depends on bargaining between the parties. At one extreme the price might be as low as the minimum long run average cost. At the other extreme the price would be set at a level which would maximize profits for the seller. In order to determine the profit maximizing price level, however, the seller would need to have knowledge of the total fisheries benefits which would accrue from leaving the water instream. Because of the difficulty in knowing the potential benefits to fisheries from the lease the best starting point for analyzing water values is at long run supply costs.

Unfortunately, the results from an analysis of long run costs are not obvious as they would be for a reservoir with basically one type of output - released water. An investment in the new pipeline on Big Creek would actually result in two qualitatively different outputs: 1) the saved water which the new efficient conveyance system makes available in the creek and 2) water delivered to the fields at a given head. The latter output is qualitatively different in location and by being under pressure at the point of delivery. The value of the "saved" water in this instance depends on how costs are shared between these two outputs. This situation is analogous to allocation of costs among joint products, however, there is no analytical solution to this problem in microeconomic theory. Lacking an analytical solution, we approached the problem another way. In this analysis three possible permutations of cost sharing were identified; two of them based on "fairness criteria" and one based on the financial feasibility of the pipeline project.

Value Based on the Supply Cost of the Saved Water

The first "fairness" based method of estimating water values is for all users of water right to share jointly in the costs based on the amount of water each uses. The period of greatest concern for DFWP is mid June through the end of September. During this period the water rights of interest use approximately 35 cfs, or 69.42 acre/feet of water per day. Rough SCS estimates of water requirements show that the irrigators operating with the proposed pipelines would require 20 cfs, thus leaving approximately 15 cfs as surplus. Over the period of interest this would amount to 4245 acre/feet of water for the irrigators and 3184 acre/feet of surplus water for DFWP. This ratio of 57% for the irrigators and 43% for DFWP could be used to allocate project costs. (The ratio would be similar if longer [eg. May to October] or shorter periods were chosen.)

In February of 1990 the Livingston SCS office compiled estimated cost figures for the Big Creek project. These estimates were very rough since they were done before any engineering work at the site had been undertaken. Using two different equipment price levels SCS estimated the total cost of the pipeline component of the Big Creek project to be between $210,239 and $350,402. This is a considerable range and indicates the preliminary nature of the estimates. Using an estimated life of 20 years and a real discount rate of 4.6% the estimated annual amortized cost of the pipeline ranges between $16,302.71 and $27,171.47. Table 71 shows how these figures translate into per acre and per acre/foot values. Also shown is the SCS estimates for the financial life of the project; 10 years at 9 percent interest.

Based on the "fairness " principle wherein each water user shares in the total costs based on the amount of water they use the per year costs of the Big Creek lease to DFWP would be $6973 to $11,653. These estimates, of course, assume a specific discount rate (4.6%) and estimated life of the project (20 years). It is interesting to note that the per acre foot values estimated with this method are within the range of other supply cost based transactions observed in the West (eg. Painted Rocks water sold at $2.00 acre/foot, Snake River Water Bank water sold at $2.50 acre/foot). The acre/foot water values calculated here are, of course, highly sensitive to the length of irrigation season over which the saved water is allocated.

Table 71
Big Creek Supply Cost Based Water Values
Costs Shared on the Basis of Amount of Water Used

	Discounting Option	
	20 Year 4.6%	10 Year 9%
Total Project Cost	210,239 -- 350,402	210,239 -- 350,402
Annual Amortized Cost	16,303 -- 27,171	32,759 -- 54,600
Total Acres Involved	1177	1177
Cost / Acre / Year	13.85 -- 23.08	27.84 -- 46.40
Total Acre/Feet June 15 - Sept 30	7428.2	7428.2
Average Acre/Foot Value	2.19 -- 3.66	4.41 -- 7.35
Implied "Fair" Cost Share to DFWP	**$ 6,973 -- $ 11,653**	**$ 14,041 -- $ 23,402**

The second "fairness" based method of allocating costs of the Big Creek pipeline would be to share costs based on the benefits that each water user receives from the water. In this instance the Big Creek agricultural interests would derive a certain level of benefits from the water as an input into their production processes. Likewise, DFWP (as stewards of the public interest) would derive a certain level of fisheries benefits from leaving a portion of the water instream. Under this method of cost sharing the irrigators and DFWP would share the costs of the pipeline based on the ratio of their total water-derived benefits. Unfortunately, we are limited to describing a broad outline of this method since total potential fisheries benefits at the site are unknown, and are beyond the scope of this study.

A final way to look at this problem is to recognize that DFWP's interests are served just as long as the project is built. The question then becomes - how large a cost share must DFWP assume for the irrigators to choose to proceed with the project. In this method an examination would be made of varying shares of total costs to be covered by DFWP and how these shares affect the

certainty that the farmers will achieve a desired level of net returns to irrigation. In other words, the farmers would first determine a level of financial risk (risk in this case is directly related to the variability of commodity prices) which they are willing to accept in undertaking the pipeline project. The lease price for salvaged water would in this case be based on the total costs and benefits to farmers and the variability of crop prices. In the case of an extremely efficient pipeline project and high, stable crop prices the lease cost could be very small or even zero. Conversely, if the pipeline offers low additional benefits to farmers and is constructed in an environment of low or erratic crop prices the lease cost could approach the total annualized cost of the system. In any event, computation of this possible negotiated outcome would require precise cost and revenue estimates. To this point no detailed engineering work has been done on the Big Creek project by SCS, therefore, addressing this third method is also beyond the current scope of this study. Additionally, net project revenues have not yet been computed for this project.

Valuation of salvaged water on Big Creek is a difficult problem in the absence of detailed cost and benefit estimates. Also, owing to the unique single buyer, single seller nature of this market traditional economic theory does not suggest an obvious solution for the market price level. Rather, the lease price in this case will be a negotiated price depending heavily on the motivations and intentions of the parties involved. An estimated water value based on consumption based cost sharing suggests a value between \$ 2.19 and \$ 3.66 acre/foot. These acre/foot estimates correspond to a preliminary total estimated lease price of \$ 6973 to \$ 11,653 per year. This estimate only includes investment cost on which SCS computes a cost share - fixed, underground distribution systems. A major point for negotiation is whether costs need also include the farmer's investment in moveable, nonunderground sprinkler equipment.

8. DRAFTING LEASES FOR INSTREAM FLOW

INTRODUCTION

In 1989 the Montana Legislature passed House Bill 707 which allowed the Department of Fish, Wildlife and Parks to lease water rights on a temporary and experimental basis, for the purpose of enhancing and maintaining instream flows. As the legislative history demonstrates, much controversy surrounds the idea of a state agency leasing water rights for instream flows.

We prepared this report pursuant to Tasks III. A. and B. of the research contract between Bioeconomics Associates and the Montana Department of Fish, Wildlife and Parks. Under these tasks, we were responsible for summarizing the legal aspects of possible lease options based upon the law and other information.

To prepare the report below, we reviewed, of course, the laws relating to leasing water rights for instream flows. Additionally, we reviewed all testimony and materials presented at the House and Senate committee hearings on HB 707. We spent several hours interviewing each set of proposed lessors and viewing the areas of the proposed leases as well as many hours of discussion among ourselves and Bioeconomics Associates on instream lease issues. In general, we tried to obtain as much information as possible relating to water leasing or water transfers for instream flows in the West from state agencies, the case law, laws of other states, law review articles, water treatises, etc.

The result of all this follows. We hope the following provides helpful guidelines in drafting leases for instream flows. In our review of the two specifically proposed leases we were struck by the highly fact specific nature and differences in the two areas. While we think the situations chosen by DFWP hold a high chance of success for instream flow leasing, we cannot stress enough that the individual leases for distinctive areas should be carefully tailored to that specific situation. Thus, a lease for one area may not look at all like a lease for another area.

With the above in mind, we attempted to structure the components of this report in a manner similar to how the components of a lease should be structured.

THE LEASE

PARTIES:

The lease should accurately identify the legal names of the parties. Particularly, the true legal owner of the water right (Statement of Claim), the Lessor, should be identified. In Montana, water rights are normally transferred by a deed which transfers the land to which the right is appurtenant. Section 85-2-424, MCA, requires a DNRC Form 608 to be filed when a transfer occurs. However, failure to file a transfer form with the DNRC does not invalidate the transfer or the new owner's right to use the water[1]. Sometimes parties forget to file these forms. Also, both the Water Court and Department of Natural Resources and Conservation should be contacted to ascertain the name of the owner of the water right. Often the DNRC will receive notice of the transfer well before the Water Court. Therefore, Water Court records may not always show the current owner of a water right. These records should be in proper order before DFWP signs a water lease.

The lease should accurately identify whether the owner is:

- a corporation
- a partnership
- an individual
- in joint ownership
- some other entity (e.g., trust or estate)

There may be situations where water rights are actually held by corporations or trusts which ownership entity is not properly identified on DNRC or Water Court records.

To protect itself, the DFWP may consider conducting title search of the underlying property to confirm ownership and any lienholders.

The proper signature on the lease of the legal owner is necessary to secure a binding lease.[2] If the water right is owned by an entity, we recommend the Department secure appropriate resolutions or documentation from the entity prescribing who is authorized to sign the lease on behalf of the entity.

PURPOSE OF LEASE:

The lease should contain some sort of statement of purpose related to the provisions of Section 85-2-436, MCA. A written statement of the purpose of the lease may be important to protect against a challenge to the lease that the state acted without authority or irrationally.

TERM:

The lease provisions should identify the number of years DFWP will lease the water right, e.g.:

> This lease commences on _____________, 1990. This lease and all rights of DFWP shall terminate upon the earlier of _________________, 1994 or the expiration or repeal of the law authorizing DFWP to enter this lease for instream flows, unless terminated earlier or renewed under other provisions of this lease.

Section 85-2-436(1)(e), MCA, authorizes an initial lease for up to 4 years with renewals for up to 10 years. Both the Swamp Creek and Big Creek parties indicated they were not willing to lease water for only 4 years. Fred Hirschy stated that it would not be economical for him to lease his water right for a period of less than 5 years. He indicated a term of less than 5 years is not sufficient time to make practical and economical ranch decisions regarding the land he otherwise irrigates with the leased right.

The Big Creek users expressed interest in a 20 year term. They propose to lease "salvaged" water obtained from installing more efficient irrigation systems. These systems will require the users to make significant economic decisions. Thus, the Big Creek users desire a lease term which provides them the security to make these decisions.

PAYMENT:

The lease should identify the amount, conditions and timing of payment. These elements of payment will be highly dependent upon the specific fact situation of each lessor and the ability of DFWP to pay. Some payment options follow:

1. Straight lease. The simplest method of payment would be a straight lease payment similar to the following:

> FWP shall pay __________________ Dollars ($________) per year as the annual rental for the term of the lease with the first payment due on or before _______________, 1990, and subsequent payments on __________________ of each succeeding year.

A straight lease would require payment whether or not the DFWP needed the water in any given year. Variations on a straight lease could include payments made monthly during the period of use or a lump sum payment made up front by DFWP for the entire lease term discounted to present value.

The Big Creek users indicated they would be most interested in a lump sum initial payment which covered the entire lease term. From their standpoint, this type of payment would provide them the most security in making the economic decision to move to more efficient irrigation systems. Inherently, there may be a concern that the ranchers do not want to be subject on a year to year basis to the budget status of DFWP.

2. Dry year or Stand-by lease. This option would require payment to the lessor only when DFWP calls for the water. This type of lease option would require specific definitions and conditions for when the DFWP may call on the water and how payment is to be calculated.

The lease would provide DFWP the right to call on the water right for instream flows when certain minimum stream flow levels are reached. The method and place of measurement for determining the pivotal stream flow should be spelled out in the lease.

Additionally, the lease provisions should spell out the notice DFWP must provide the lessor to exercise its lease of instream flows in any given year.

Also, the lease provisions should define either how much the lessor will be paid in absolute terms if the DFWP calls on the water or upon what factors the payment will be determined in any given year. Factors include compensating the lessor for lost production revenues, disruption of planning, and any expenses incurred before being notified the land could not be irrigated that season.

An example of this type of payment provision follows:

> Prior to March 1st of each year, the DFWP will notify the lessor in writing whether it will exercise its option to use lessor's water right for instream flows. If DFWP notifies lessor of its intention to use the water right for instream flows, DFWP shall pay to lessor an amount of _________________dollars ($_______) on or before April 1st of that year. If DFWP fails to notify lessor by March 1st of any given year, then DFWP shall be deemed to have waived its right to use lessor's water right for instream flows during that year.

Obviously, there are many variations on this type of provision. For instance, the notice provisions could be shortened or be worded to place more flexibility in the hands of DFWP. E.g., "The DFWP shall give lessor two weeks prior written notice of the date within the Period of Use it will begin exercising its power to use the water right for instream purposes." In other words, one of the decisions that should be made in drafting this type of lease should be whether the DFWP

has the power to exercise its rights only on a year to year basis or upon a discretionary basis within any season. If made on a year to year basis, the notice date should be carefully considered. On one hand, DFWP would need time to analyze and predict upcoming stream flows based on snowpack, precipitation and other conditions. On the other hand, the Lessor will need lead time to make sound ranch decisions.

Payment options could be added. E.g., "In addition to this payment, DFWP shall pay lessor's reasonable expenses incurred during the present calendar year in preparation of the land for irrigation prior to DFWP's notice of its intention to exercise its power to use the water right for instream purposes."

However, the more flexibility the DFWP has in payment and in exercising its power to use the water instream, the less certainty the irrigator has in making sound economic decisions. A "stand-by" lease leaves the lessor/rancher facing substantial uncertainty in planning crop or livestock rotations, marketing strategies, and in equipment and other material purchases. On the other hand, stand-by leases in which DFWP pays for crop or production loss in a particular year is probably cheaper than purchasing the water right or paying for it whether it is needed or not.

Both the Hirschys and the Big Creek users stated that they were unwilling to face this type of uncertainty in a lease. Both wanted payment regardless of whether DFWP needed the water or not. They indicated that being left to a season to season (or part of a season to part of a season) notice of use for instream flows with payment conditioned upon use contained too much uncertainty for them to make rational ranch decisions.[3]

For the Big Creek users, a stand-by type lease is particularly disruptive because of the type of crops they grow with irrigation. For them to irrigate, for instance, in May and June and then have DFWP call on the water for the rest of the season is a complete waste of time, water and crop because the type of crops grown need water most of the summer to be of any value at all. In situations where a lessor is irrigating pasture or where at least some irrigation during the summer is better than none, a stand-by lease may be the most beneficial for both parties.

3. Hybrid leases: One solution to the uncertainty presented by a pure stand-by lease is to incorporate elements of a straight lease. For instance, a lessor probably, at least, needs notice on a year to year basis rather than being subject to being cut off at any point in an irrigation season. Additionally, an initial "option" type payment could be paid by DFWP upfront with additional payments conditioned upon actual calls for water.

Ideally, these additional payments should be fixed so the parties do not end up in a dispute over the reasonableness of additional expenses.

For example in Utah a city paid a farmer $25,000.00 up front for a 25 year "dry-year" option granting the city the right to use the water when certain dry year conditions were met. The agreement provided that in any year the option was exercised, the city must pay the farmer an additional $1,000 and 300 tons of hay to maintain the farmer's livestock.[4]

WATER RIGHT(S) SUBJECT TO LEASE:

One of the most difficult tasks of the leasing process will be defining the water right leased, both in size and shape, and defining how the water right may be used for instream flows. The lease should expressly describe the water right leased and DFWP's rights to protect it.

Essentially, two provisions in the law circumscribe the water right to be leased. Section 85-2-436(2)(d) states the following:

> The maximum quantity of water that may be leased is the amount historically diverted by the lessor. However, the amount historically consumed, or a smaller amount if specified by the department in the lease authorization, may be used to maintain or enhance streamflows below the lessor's point of diversion.

Section 85-2-402, MCA, allows the DNRC to authorize a lease if the following condition is met:

> The proposed use will not adversely affect the water rights of other persons or other planned uses or developments for which a permit has been issued or for which water has been reserved.

The lease should be drafted to meet the conditions imposed by these sections of the law.

The general elements of a water right include the following:

Priority date
Flow rate
Volume
Place of use
Period of use
Point of Diversion
Means of conveyance

The lease should describe the Statement of Claim(s) upon which the lease is based. Attached as an exhibit should be a copy of the Statement of Claim(s) or the Temporary Preliminary or Preliminary Decree abstract(s).

Next the lease should describe the portion of the water right which is consumed and, thus, protectable below the lessor's point of diversion. Defining the amount consumed "requires knowledge of the entire irrigation or water use system, the amount diverted, the return flow, the climate, and the vegetation receiving water (crop and non-crop)."[5]

However, "consumed" should not be limited to only water used in the growing process. Since the water leased is for maintaining instream flows "consumption properly includes all water lost to the stream... . Thus, irrigation water which seeps into deep aquifers not tributary to the stream or which collects on the surface and evaporates is also 'consumed'"[6] and should be included in the amount protected. Another similar way to define "consumed" is by the amount of water irretrievably lost to the system.

The amount historically "consumed" will depend entirely upon the individual historical, climatical, hydrological, geological, agricultural, etc. facts of each case. Without a statutory or administrative rule mandating a particular method of determining the amount "consumed", the "legal" method should be any method which can be rationally defended. In other words, to protect itself from challenge, the DFWP should have a written record of how it determined the amount "consumed" for purposes of a particular lease.

We believe an "irretrievably lost" type standard is in accord with Montana water law and, in theory, assures the maximum amount possible will be protected while not adversely affecting other appropriators. Upstream junior appropriators from the target right have always been subject to the full diversionary (as opposed to consumptive) entitlement of the appropriator. Similarly, downstream junior appropriators have never relied on waters irretrievably lost by the senior appropriator's diversion and use. The key as discussed below is to define consumption in a manner which does not decrease the timing or level of return flows nor increases the historical levels of beneficial consumptive use.

The following is an example of how this portion of the lease could read: (For simplicity's sake, we have used the elements of the Hirschy right instead of blanks.)

> Lessor's water right represented by Statement of Claim No. 41D-W-194957 is the subject of this lease. Statement of Claim No. 41D-W-194957 [or decree abstract of statement of

claim no.] is attached as Exhibit A and is fully incorporated by reference to this lease. Lessor hereby leases this water right to DFWP for maintenance and enhancement of instream flows on Swamp Creek.

However, X c.f.s. is the amount of Lessor's diversionary entitlement historically consumed. Only X c.f.s. shall be used to maintain or enhance streamflows below the Lessor's point of diversion unless the Dept. of Natural Resources and Conservation specifies a smaller amount in its authorization of this lease.

Lessee shall have the right to use X c.f.s. pursuant to the terms of this lease to maintain or enhance stream flows for the approximately 2.5 mile length of Swamp Creek from Lessor's point of diversion in the NW¼NE¼SW¼ of Sec. 20, T.2S., R.15W., PMM, to the confluence of Swamp Creek with the Big Hole River. Lessor's point of diversion and the protected length and location of the stream reach is shown in detail on the map attached as Exhibit B incorporated into this lease by reference.

The priority of the water right leased is [same date as Statement of Claim].

Section 85-2-436(2)(d), MCA, allows the DFWP to lease the full amount of Lessor's diversionary entitlement, but use only the amount consumed for instream flow protection below lessor's point of diversion. Thus, apparently DFWP has the right, just as the owner does, to demand the full diversionary entitlement from upstream junior appropriators. However, in the protected stretch, DFWP can only demand from downstream junior appropriators the consumed amount be left in the stream (after accounting for whether the protected stream stretch is a naturally losing stretch of stream and historical irrigation practices of the senior appropriator/lessor.)[7]

In the Big Creek and Swamp Creek situations, the potential for adversely affecting downstream junior appropriators is small since there are no junior appropriators within the protected stretch or within a reasonable distance downstream from the protected stretch.

The Big Creek users propose to lease "salvaged" water to the DFWP. Additionally, they intend to enter an agreement among themselves where they all agree to share a common priority date for all their water use.[8] Essentially, the goal is to lease to DFWP the water salvaged under this contract. Therefore, the lease drafted for these users should make particular reference to any private agreements of the lessors and how the private agreement affects the amount, priority date, etc. of the water in the hands of the DFWP.

LESSEE'S USE:

As noted above, a primary hurdle the leasing arrangement must overcome is the DFWP lease and use not adversely affect other appropriators. Thus, the lease should anticipate possible adverse affects and contain provisions which mitigate these affects or circumscribe DFWP's use to prevent the affects. In general terms, an instream flow lease use could result in the following adverse affects.[9]

1. Reduced Return Flows

Reduced return flow is the most common injury likely to occur without careful definition and planning. The manner in which the lessor irrigates may be producing return flows upon which others downstream rely. By leaving that water in the stream, there is potential for it to geographically and hydrologically miss the reliant downstream appropriator.

The potential also exists for an abuse in the timing of return flows. In some situations, an irrigators early season use and spreading of water on fields contributes to return flows later in the drier part of the season. Thus, if the water stays instream, this adversely affects the "delay" upon which the downstream appropriator relies.

Opponents to HB 707 consistently argued against the bill precisely because instream flow use of historically diverted water would deplete aquifers, wells and the return flows upon which downstream appropriators rely.

Initially, choosing stream reaches and rights which do not rely on or contribute to return flows is the best way to mitigate or prevent this harm. In the Big Creek and Swamp Creek situation there do not appear to be any appropriators who rely reasonably on the return flows or timing of the return flows of the rights proposed to be leased.

Reduced return flows can be prevented by properly defining the amount "consumed" and by accounting for natural stream losses or gains in the monitoring and enforcement of the protected stretch of stream. In cases where the timing of return flows is important, mitigation measures might include some sort of storage facility to insure return flows are released when historically available.[10]

2. Changes in the Seasonal Period of Use

As DFWP recognized in the legislative battle to pass HB 707, the lease must take into account "the shutoff of a diversion associated with a water right under normal irrigation practices, harvesting, climatic conditions, and cooperative practices with

other irrigators."[11] Of course, an extension of the period of use of the leased right can cause injury if the DFWP would seek the right to demand the water right from junior appropriators outside the period of use in which the lessor has the right to demand water. However, mere shifts in the dates of use within the lessor's stated period of use could also cause injury. For example, if DFWP takes the full volume requirement of the lessor's appropriation in August, rather than spreading it over the entire irrigation season as was done by the lessor, could cause immediate harm to junior appropriators even if the total volume used remains the same.[12]

Given the factors listed above, there are certain times during the irrigation season, the senior appropriator allows junior appropriators, whether upstream or downstream, to use the water because the senior appropriator has no need for it. For instance, during harvesting, the senior appropriator has no beneficial need or use for the water, therefore, historically this water is available to the junior users.

3. Stream Conveyance Losses

Another form of potential harm to other appropriators is structuring the DFWP's right of protection in a manner which forces junior appropriators to participate in increased stream conveyance losses. For instance, assume DFWP leases 5 c.f.s. of water from the lessor and determines that 3 c.f.s. is the amount consumed. 3 c.f.s. is the amount protectable below lessor's point of diversion. Assume DFWP has a monitoring device within the protected stretch, but 1 mile below lessor's point of diversion. Assume hydrologically that 6 c.f.s. must be flowing by lessor's point of diversion to supply 3 c.f.s. at the monitoring device. Assume water flows grow short and DFWP starts looking to upstream appropriators from lessor's point of diversion to fill the 3 c.f.s. protectable right. DFWP will not have the right to demand from upstream junior appropriators that they supply water to this monitoring point to fill completely the 3 c.f.s. right if stream loss is such that the junior appropriators are supplying more than 5 c.f.s. at the point of lessor's diversion. In the example given, junior appropriators would have to contribute 1 c.f.s. more than historically required to meet lessor's senior right to provide the 3 c.f.s. at the monitoring point.

Thus, the monitoring plan should be expressly described in the lease in a manner which demonstrates other appropriators will not be harmed. The monitoring plan must account for natural stream losses or dewatering which occurs in the protected stretch.[13]

For the most part, the potential for injury will occur in two situations: One, when the DFWP calls on upstream junior water rights in a manner not consistent with or more demanding than lessor's historical use and demand for water; and, two, if there are junior appropriators below lessor's point of diversion within or reasonably close to the protected stretch. In the latter situation DFWP, in its monitoring and use plan, must be careful not to deprive or prevent the downstream junior appropriator's use of water which has otherwise been available for this downstream user regardless of or due to the lessor's use of his senior right. As mentioned above, factors to consider include stream loss or gain[14], return flows, historical irrigation, harvesting and use patterns.

Again, by selectively choosing stream stretches which do not include downstream appropriators within or near the protected stretch, the DFWP will substantially reduce potential harms and make lease drafting that much easier.

Additionally, applying the above considerations may require the DFWP to define its period of use within the lessor's period of use and consider limitations on the total "protectable" amount of volume. For instance, it may be necessary to look at the ratio of average days the lessor's water is actually diverted from the stream compared to the entire number of days in the lessor's claimed period of use. From these figures the lease provisions may be worded as follows:

> Lessor's period of use is from May 1 to October 31st of each irrigation season. DFWP's right to enforce the leased water right for instream flows shall not exceed X number of the total number of days between May 1 to Oct. 31st. [X = amount of days on average the lessor is actually diverting water.]

Or,

> Lessor's period of use is from May 1 to October 31st of each irrigation season. Lessor on average uses and consumes approximately Y acre-feet in total volume during this irrigation season. DFWP shall have the right to enforce its instream flow lease until, as a result of Lessor's not diverting the water leased, a total of Y acre-feet have flowed by Lessor's point of diversion as measured under the Monitoring Plan.

In the first example, more detailed language may be needed in which an actually calendar of enforceable days or weeks is appended to or included in the lease. In the second example, more detailed language may be needed to define how Y acre-feet will be measured and deemed to have been used.

The DFWP and a particular lessor may also consider limiting DFWP's period of use to something less than the Lessor's. For example, Fred Hirschy indicated he would be willing to lease his water right for August and September only as opposed to May through September. In his case, he indicated he could and would use the water between May and July. However, Mr. Hirschy stated the lease price would be the same whether DFWP leased the water for 2 months or 6 months.

On the other hand, the Big Creek users would gain no benefit from leasing water only in July and August, for example, because the type of crops they irrigate are not benefitted from irrigating only in May and June and could die or be retarded if left dry in July and August.

Assuming no downstream appropriators exist within or near the protected stretch, a simple lease provision which protects against harm and against natural stream dewatering could read as follows:

> DFWP shall have the right to enforce its lease of Lessor's water right for no more than ____ days [or use total volume amount] within the period of May 1 to September 30th of each year. DFWP may enforce this right against upstream junior appropriators in accordance with law only to the extent of securing a maximum of ____ [amount of Lessor's diversionary entitlement] c.f.s. at Lessor's point of diversion. Nothing herein shall grant the DFWP the right to demand water from upstream junior appropriators if the water demanded will not otherwise naturally reach Lessor's point of diversion.

If there are no downstream appropriators involved, then there is no need to be concerned about protecting the "consumed" amount within the protected stretch (except against applicants for new appropriations or diversions within that stretch). Thus, the need only is to get the maximum amount allowable to Lessor's point of diversion. This cuts down on monitoring needs and makes the instream right easily enforceable by a water commissioner. Montana law prohibits a downstream senior appropriator from making demand upon an upstream junior appropriator where the water, if otherwise left in the stream, does not reach the senior appropriators point of diversion.[15]

MONITORING PLAN:

The lease should define what types and where monitoring devices will be placed and the schedule for monitoring. For example,

> Prior to ______________, 1990, DFWP shall install monitoring devices at the positions located on the map attached as Exhibit B. Once installed DFWP shall monitor stream flows according to the schedule attached as Exhibit C. DFWP shall

pay all costs of installing and maintaining the monitoring devices and shall provide the personnel necessary to complete the monitoring schedule.

ACCESS:

The lease should expressly provide DFWP access to the stream and monitoring stations. If necessary, a map of routes could be attached to the lease. Additionally, time limitations on access or notice to Lessor requirements should be added to the lease if necessary. We recommend the inclusion of the following type of language:

> Except as expressly provided for DFWP's duties under this lease, nothing herein grants any person, agency or other entity a right of access to Lessor's property except as may otherwise be provided by law.

LESSOR'S USE OF WATER:

The lease should define whether or not the Lessor has the right to use the water right within the DFWP's period of use, if certain conditions are met. Fred Hirschy, for example, indicated that he would like to use the water if the stream level is above a certain critical amount. Likewise, in the Big Creek situation the lease should make clear that DFWP is leasing only salvaged water and the Big Creek users have the right to use the other portion of the water rights.

In cases not dealing with salvaged water, care should be taken in drafting any right of Lessor to use the leased water right during the period of DFWP's right to protect the instream flow. If not careful in tying this provision to others in the lease, problems could arise with 1) the calculation of the volume or days DFWP is entitled to protect, 2)the Lessor being accused of actually making a new appropriation for which no permit has been issued, and 3) disputes between the DFWP and Lessor over measurements and monitoring.[16]

RESPONSIBILITIES AND OBLIGATIONS OF BOTH PARTIES:

The lease should expressly spell out the identifiable rights and duties of both parties not set forth elsewhere in the lease.

1. Who will pay the transaction costs? Presumably DFWP will pay for the following types of costs and the lease should make this clear:

- necessary hydrological or other-types of studies
- title searches
- legal fees and costs associated with the DNRC authorization for

change process
- any filing or administrative fees associated with lease
- satisfying state and federal laws[17]
- compensation to impaired water users
- costs of mitigating adverse affects or environmental impacts.

2. Consider adding a statement to the effect:

> DFWP will actively and diligently pursue its duties to monitor and enforce Lessor's water right for instream use to insure no abandonment or diminishment of the Lessor's water right occurs.[18]

3. The lease should state who is responsible for pursuing the underlying Water Court adjudication of the water rights at issue. Presumably the owner will be responsible for these actions, fees and costs. However, DFWP may desire notice of Water Court actions concerning the leased right to be in a position to protect its leasehold interest if necessary.

4. Consider: "When finished with conducting any activity under this lease, DFWP shall return Lessor's gates, fences and property to the condition as found when the activity was started."

5. Consider: "Lessor shall not unreasonably interfere with DFWP's rights and duties under this lease."

6. Consider: "DFWP shall diligently perform all duties and obligations required by the Montana water leasing statutes, the DNRC authorization of lease and other laws, rules and regulations."

7. A provision similar to the following should be added:

> Should a water dispute occur regarding the administration and distribution of DFWP's leased water right and other rights, DFWP shall take all actions necessary to defend, pursue, or otherwise participate in any court or administrative action involving the administration or distribution of DFWP's leased right. Further, DFWP shall comply with or otherwise perform according to any valid order regard the administration or distribution of the leased water right. DFWP shall pay any and all costs and fees associated with such actions including but not limited to the amounts assessed against DFWP for a water commissioner's appointment, fees and expenses incurred in the commissioner's administration and distribution of the DFWP's and others' water rights.[19]

In general, the guarantees and obligations of each party should be listed and defined in the lease.

DEFAULT

The lease should contain provisions defining the conditions of default, e.g.:

DEFAULT: Upon failure of either party to carry out any material provisions of this lease, the other shall serve a written notice specifying the default. The offending party shall have 30 days from the date written notice of default is deposited in the U.S. Mails to correct the default. If the default if not corrected within 30 days of notice, (or, if such default is curable but requires acts to be done or conditions to be remedied which, by their nature, cannot be done or remedied within such 30 day period, if the DFWP does not commence the same within such 30 day period and thereafter diligently and continuously prosecute the same to completion), then the Lessor shall have the remedies listed below.

REMEDY ON DEFAULT: If an event of default occurs, Lessor may terminate this lease and retake possession without additional notice. In addition, the Lessor may pursue any other remedy at law or equity applicable to the situation and such remedy or remedies shall be cumulative to the extent not inconsistent.

NOTICE

The lease should define how notice is given, e.g.:

NOTICE: Any notice to be given hereunder shall be in writing and shall either be served upon the party personally or served by registered or certified mail, return receipt requested, directed to the party to be served at the address of the party set forth on the first page of this agreement. A party wishing to change his designated address shall do so by notice in writing to the other party. Notice served by mail shall be deemed complete when deposited in the United States mail. Rejection or other refusal to accept or the inability to deliver because of changed address for which no notice was given shall be deemed to be receipt of the notice.

TERMINATION

In addition to termination by default or by expiration of the lease term, the parties may want to spell out other conditions of termination. For example:

1. In the Big Creek situation, the lease should spell out what happens if due to circumstances beyond anyone's control (Acts of God), the lessors irrigation systems producing the salvaged water are destroyed? The lease should spell out whether the lease terminates.

2. May consider including a provision that the parties may terminate the lease upon mutual agreement.

3. May consider including a provision that one party may terminate the lease upon, for example, one year's notice to the other. This provision would probably not be desirable to either party.

In any event, if the lease is terminated, by conditions other than expiration of the term or default, the lease should spell out whether any annual payments should be prorated to the date of termination, or whether any portion of lump sum payments should be refunded.

RENEWAL:

The conditions for renewal should be defined in the lease. Frankly, it is unlikely any new lessor will be willing to make renewal of the lease mandatory if DFWP chooses to keep paying. Therefore, more likely a provision as follows should be included:

> Pursuant to Section 85-2-436(e), MCA, the parties may renew this lease by mutual agreement for up to 10 years. The parties agree that any mutual agreement to renew this lease includes the right to renegotiate its terms and payments. If the parties agree to renew this lease, DFWP shall be responsible for all fees, costs and duties required under Section 85-2-436(e), MCA, for providing notice of the lease renewal and, if necessary, securing a new lease authorization from the DNRC.

MISCELLANEOUS:

The following miscellaneous provisions should also be added to a lease in some form:

1. Time shall be of the essence of this agreement.

2. A provision regarding attorney's fees should be added. Under Montana law parties may contract to provide the winner of a suit with attorney's fees from the loser. This type of provision can sometimes be a strong incentive to settle short of going to court.

ATTORNEY'S FEES: If either party defaults in their performance and the other party employs an attorney because of such default, the defaulting party agrees to pay, on demand, all costs, charges and expenses, including reasonable attorney's fees, reasonably incurred at any time by the other party because of the default.

In the event the Lessor shall be required to appear in a Federal bankruptcy proceeding because of an action commenced by the DFWP or the DFWP's creditors, the DFWP agrees to pay the Lessor's reasonable attorney's fees, court costs, witness fees and any other costs caused by said bankruptcy action and said sums shall be due by the DFWP to the Lessor upon demand. This clause is intended to be bi-lateral in the event the Lessor becomes the person involved in a bankruptcy proceeding to protect DFWP's interest in this agreement.

3. The lease should make clear whether or not it is subordinate to mortgages and liens. Most likely, a lessor will desire subordination of the lease to prevent the lease from interfering with any financing arrangements. Therefore, consider adding the following type of language:

> This lease and DFWP's interest in Lessor's water right are and shall be subject, subordinate, and inferior to any liens or encumbrances now existing or hereafter placed on the property (which property as an includes the leased water right as an appurtenance), all advances made under any such liens or encumbrances, the interest payable on any liens or encumbrances, and any and all renewals or extensions of liens or encumbrances.

If DFWP is concerned that the Lessor will be subject to foreclosure during the lease and is concerned a lender will want the property without this lease, the DFWP may consider, as a separate matter, asking the underlying contract for deed, mortgage or lien holder, to consent in writing to the lease.

The DFWP may consider providing language in the lease which requires the lessor to give the DFWP notice if the lessor encumbers the property to which the water right is appurtenant during the lease term.

4. Does a Form 608 or other notice need to be filed with Water Court or DNRC to protect DFWP's interest? The lease should define which party has responsibility in providing notice of DFWP's interest in the water right.

5. The lessors were very concerned about DFWP holding them harmless and indemnifying them for any suits or actions which

arise out of the leasing arrangement. For instance, while the law makes it clear that the water right reverts to the lessor upon expiration of the lease, that may not stop some entity from trying to maintain the rights instream. The lessors expressed the concern that while this type of suit may not succeed, the lessors do not want to pay for the cost of defending it. Thus, the following type of provision should be addressed in the lease:

> DFWP shall indemnify and hold Lessor harmless for all liability, claim, loss, cost, damage, penalty or expenses sustained by lessor, including attorney's fees and other expenses of litigation arising out of the following:
>
> a. On account of or through DFWP's use of the leased water right and Lessor's property;
>
> b. Arising out of, or directly or indirectly due to, any failure of DFWP in any respect to promptly and faithfully satisfy its obligations under this lease or for the willful or negligent violation of any law, statute or ordinance by DFWP;
>
> c. Arising out of, or directly or indirectly due to, any accident or other occurrence causing injury to any person or persons or property resulting from the DFWP's use of the leased water right, resulting from DFWP's use of Lessor's property associated with the use or resulting from any DFWP improvements installed and maintained under this lease;
>
> d. All claims arising from the conduct or management of this lease by DFWP or arising from any act or negligence of DFWP or its agents, contractors or employees associated with the management, conduct, obligations, improvements installed or duties required under this lease;
>
> e. All claims of whatever nature challenging the reversion of the leased water right to the Lessor upon the proper termination expiration, default or otherwise of this lease; and,
>
> f. All claims of whatever nature challenging Lessor's water right or attempting to diminish Lessor's water right in any manner arising due to or based upon Lessor's lease of the water right to DFWP.
>
> Additionally, in the event of any claims made or suits filed, Lessor shall give DFWP prompt written notice, and DFWP shall have the right to defend or settle the same; PROVIDED HOWEVER, that for any claims made or suits filed concerning paragraphs (e) or (f) above, Lessor retains the right to participate in such suit as a separate party with

counsel of Lessor's choice and DFWP shall not have the power to settle such suit except with the consent of Lessor.

This indemnification and hold harmless provision should be specifically drafted to meet the needs of the parties to the lease. The above is only given as an example.

6. While Section 85-2-436(2), MCA, appears to imply that DFWP is the only entity which can hold leases for instream flows, the following provision should probably be added to a lease:

> SUBLEASE AND ASSIGNMENT: DFWP shall not assign or sublet this lease.

7. Virtually all pre-1973 water rights in this State are undergoing adjudication. As a practical matter, if we were to wait for final adjudication before leasing a water right (or undergoing any other type of water development), these programs in Montana would be on hold for decades. For example, the temporary preliminary decree for the Big Hole area is not even out yet, and the upper Yellowstone's is just in the temporary preliminary decree stage. Therefore, the lease should recognize that the water right leased is subject to the adjudication, e.g.:

> DFWP leases the Lessor's water right subject to the Montana Water Court adjudication process. Nothing herein shall be used as evidence to diminish Lessor's water right claim in the Montana Water court adjudication.

8. The following provisions should also be added:

> LIENS: DFWP agrees that DFWP will commit no act or incur any obligation which will cause a lien to be filed against the leased water right.
>
> NON-WAIVER: A waiver by the Lessor of any default or breach by the DFWP of any of the covenants, terms or conditions of this lease shall not bar the Lessor from Lessor's right to enforce such covenants, terms or conditions or to pursue the Lessor's rights arising out of any subsequent default or breach thereafter.
>
> ENTIRE AGREEMENT: This agreement contains the entire agreement and understanding of the parties and supersedes any and all prior negotiations and understandings. This agreement shall not be modified, amended or changed in any respect, except by written document signed by all parties hereto.
>
> BINDING EFFECT: The provisions of this lease shall be binding upon the heirs, personal representatives,

administrators and successors of the parties in like manner as upon the original parties, except as provided by mutual written agreement.

NO PARTNERSHIP: It is expressly understood and agreed that this lease shall not be deemed to be or intended to give rise to a partnership relationship.

CONCLUSION AND RECOMMENDATIONS

The above discusses the general types of provisions and the drafting principles for a water lease under Section 85-2-436, MCA. In this process, we attempted to guide the drafter to use the lease as much as possible for addressing the issues and standards which arise under Sections 85-2-436 and 85-2-402, MCA, for lease authorization.

Section 85-2-436(1)(b), MCA, requires DFWP to develop a complete model lease. If we learned any thing in our preparation of this report, we learned that the heart of any water lease will be highly and necessarily specific to the water right and stream stretch proposed for leasing. Thus, we advise the drafter to rely upon a model form only as a starting point and take care to design the lease to the specific demands of the individual situations. Given the material we researched and viewed from a variety of sources including from the DFWP, we believe the DFWP's best course of action would be to start drafting specific leases. Frankly, despite the legislative mandate, attempting to develop a generic "model" lease may prove an inefficient use of time and resources given the highly fact dependent nature of these leases.

Finally, in developing this report, several recommendations occurred to us for enhancing the instream leasing process or laws:

1. A bill similar to the failed S.B. 450 should be passed providing a definition of salvaged water and its ability to be leased. Otherwise, irrigators have no incentive to go to more efficient systems. "State law could provide that water presently diverted and used under an existing water right that can be conserved without injury to other water rights (and other protected interests) may be transferred to a new use with the same priority as the original right."[20] Projects in Wyoming and California exist where public entities finance the water right owner's irrigation improvements so the entity can use the conserved water.[21] This is precisely what the Big Creek users would like. Oregon has enacted a law allowing conversion of "conserved" water to instream use under a "consumed or irretrievably lost" standard.[22]

2. Section 85-2-436(1)(e), MCA, should be amended to authorize longer initial lease terms of at least 5 years.

3. Consider modifying the law regarding lease authorization, i.e, change authorization from DNRC, to include expressly in the law (as in Colorado and Utah) that injury to other rights could prevent the lease authorization only if terms and conditions could not be devised to mitigate the injury or if satisfactory compensation cannot be made to adversely affected water right owners. Additionally, consider enacting authorization for a "trial period" lease to see if injuries happen.[23]

4. While the abandonment statute clearly states that an instream lease in no way constitutes abandonment, consider adding language to the statutes clearly stating an instream lease in no way can be used to diminish any element of the Lessor's right upon reversion to the Lessor or in the adjudication process.

5. Identify any wetlands or environmental laws which may be triggered by DFWP (state agency) instream lease actions or by dewatering areas irrigated for long periods for the purposes of considering what exemptions in the law may be required.

6. Consider seeking legislative authority for rule making under the instream lease statutes for the purpose of adopting standards and guidelines for applying the principles discussed in this report.

7. Throughout the legislative history of HB 707 and in our interviews of the potential lessors, many people mentioned that this water leasing solution will not be feasible in all areas and that the key to a long-term solution for instream flows is storage, particularly, increasing off-stream storage facilities. Unfortunately, no one can afford these facilities. Many people recommended the state consider and develop new methods which encourage environmentally sound development of relatively small storage facilities.

8. Section 85-2-436(2)(d), MCA, and Section 85-2-402, MCA, are somewhat redundant in that applying "adverse affect" principles of water law requires, we believe, only the amount consumed is protectable below the lessor's point of diversion. However, the controversy surrounding the passage of this statute demands this language from a political perspective. The following amendments to Sec. 85-2-436(2)(d) may be helpful for clarity:

a. Define "historically diverted" as meaning "diversionary entitlement". Relate the maximum amount capable of being leased to the amount the lessor "legally" has the right to divert. This would help avoid someone from using the leasing process as a forum to adjudicate or litigate the lessor's water rights.

b. Consider changing the 2nd sentence to read similarly to the following:

However, only the amount historically consumed, or a smaller amount if specified by the department in the lease authorization, may be protected against other rights below the lessor's point of diversion for the maintenance or enhancement of streamflows.

Based our analysis, we believe the present "may be used to maintain or enhance streamflows" language means what is said in paragraph b. above. However, the present language could be construed to mean that a lessor _must_ keep diverting the diversionary entitlement less the amount consumed. _See_, e.g., footnote 13.

One may also consider expressly stating that the amount which may be called upon _at_ the lessor's point of diversion is the total amount leased, i.e., lessor's diversionary entitlement. Under the current language, one may argue the DFWP can only call on the amount consumed from upstream appropriators eventhough historically the lessor had the right to call on upstream appropriators for the full amount of the diversionary entitlement.

ENDNOTES

1. §85-2-403(1), MCA.

2. For example, in Moore v. Adolph, 47 St. Rept. 730 (1990), the Montana Supreme Court upheld a district court's ruling that a signature of a son on behalf of a father on a water contract was invalid where there was no written evidence the father gave his son the authority to sign or ratified his son's signature. The Court invalidated the assignment of the water contract 25 years after the son purportedly signed for the father and despite evidence the father orally agreed to the son's signing.

3. On the other hand, the Hirschys, for instance, indicated they would desire the power to use the water right when the level of the Swamp Creek was above the critical minimum levels. Regardless, of whether payment is conditioned upon use or not, the lessors right to use the water should be clearly defined in the lease.

4. Colby, "Sources of Water I: Agriculture - The Deep Pool?", p. 24, in Moving the West's Water to New Uses: Winners and Losers, (11th Annual Summer Program, Natural Resources Law Center, University of Colorado School of Law, 1990).

5. Kreag, "Transferring Conserved Water: the Oregon Experience," p. 11, Moving the West's Water to New Uses: Winners and Losers, (11th Annual Summer Program, Natural Resources Law Center, University of Colorado School of Law, 1990).

6. Gould, "Water Rights Transfers and Third-Party Effects", XXIII Land and Water L. R. 1, 20-21 (1988). Interestingly, Exhibit 15 presented at the Montana House of Representatives Committee on Natural Resources hearing on HB 707 on February 17, 1989 stated many methods of consumptive use estimation are available. This exhibit stated that the DNRC generally uses the Blaney-Criddle method which concentrates on crop consumption of water, but the exhibit recognized irrecoverable losses occur depending on the irrigation practices, conveyances systems and hydrogeology of the particular area. The above cited article criticizes the Blaney-Criddle method for estimating consumption particularly where the estimate is for the purpose of determining the amount which may be transferred to instream flows.

See, Lamb, "Quantifying Instream Flows: Matching Policy and Technology," Chapter 2 of Instream Flow Protection in the West, (MacDonnell, et.al., eds., 1989), for a discussion of the various techniques for quantifying instream flows.

7. It should be noted that at numerous places throughout the legislative history of HB 707 references are made that only the consumed portion can be leased below the lessor's point of diversion. See, Minutes and Exhibits of February 17, 1989 House

Committee on Natural Resources hearing on HB 707 and Minutes and Exhibits of March 15, 1989 Senate Committee on Agriculture, Livestock and Irrigation hearing on HB 707. We think it would be more accurate under Section 85-2-436(d), MCA, to refer to the "consumed" amount as the amount that can be "protected" below the lessor's point of diversion.

8. By contract, appropriators can adjust their priorities as among themselves. See, In re Water Rights of Fort Lyon Canal Co., 519 P.2d 954 (Colo. 1974).

9. See, Doney, Montana Water Law Handbook, Sec. 2.9, pp. 75-80 (1981) for a discussion and comprehensive list of cases and law concerning the "no adverse affect" rules.

10. See, Gould, supra n. 6, p. 18.

11. Exhibit 2, "Questions and Answers on the Instream Flow Leasing Bill", Senate Committee on Agriculture, Livestock and Irrigation Hearing on March 15, 1989.

12. Gould, supra n. 6, pp. 14, 27.

13. Another form of conveyance loss harm may exist where there are multiple users of a ditch and DFWP proposes to lease only one of the rights in the ditch. In this case, the amount "consumed" by ditch conveyance and seepage may not be properly leased or protected instream. In all probability a portion of the diversionary entitlement of the leased right in this scenario, contributes to and supports the flow of the other rights down the ditch. In other words, each right helps carry the other down the ditch and the combination of rights results in less conveyance loss in the ditch than if, for instance, only one right were conveyed down the ditch. Appropriators remaining in the ditch may argue the instream lease of one right increases the amount of water they lose to the ditch's conveyance loss. Therefore, in this scenario, the DFWP may not be entitled to lease the full right without accounting for the burden that will be placed on the remaining ditch users.

Likewise, the legislative history of HB 707 contains references to concerns that taking water out of inefficient ditch systems for instream flows will deplete wells or other water systems which rely on the inefficient seepage. The question then arises whether the lessor is mandated to keep a certain amount of flow in a ditch to prevent adverse affects. The law probably does not demand an appropriator maintain his inefficiency. For example, what is the difference between leasing the right for instream flows and the appropriator lining his ditch or just quitting irrigation and using the land for something else? In the latter two scenarios, it is doubtful that others can force the appropriator to maintain the inefficient system.

14. A downstream junior appropriator within the protected stretch will be interested, in particular, in protecting natural stream gains for use. For example, assume lessor is entitled to 1 c.f.s. at a point 1 mile above DJA (downstream junior appropriator) who has a 1.5 c.f.s junior right. Assume that the stream flows 2 c.f.s. at the DJA's diversion point even when lessor is depleting the stream at his point of diversion by diverting an entire 1 c.f.s. Assume further that lessor's 1 c.f.s. is entirely consumed. If DFWP leases the 1 c.f.s. for instream flows, it may not have the right to demand DJA stop diverting at least 0.5 c.f.s. if DJA's water right is from natural stream gains even though DJA's diversion is in the protectable stretch.

15. See, Doney, supra n. 9, p. 71 and the cases cited therein.

16. One reason given in the legislative history of the need for HB 707 relates to the fact that instream flow water reservations under Sections 85-2-316 or 85-2-331, MCA do not have a sufficient priority date to do anything but maintain the "status quo". If the DFWP desires to enter leases which allow the Lessor to use the water right in certain situations during the DFWP's period of use, the DFWP may consider backing up the lease with an instream flow reservation. This would give the DFWP an identifiable, protectable and legal reservation of a certain minimum which could help alleviate the potential problems listed.

17. For instance, in a given case, will any environmental assessments or impact statements be required? Or, in a given case, will the change of use of water to instream dry up any protected wetlands?

18. Despite the fact that Section 85-2-404(4), MCA, states that a lease does not in any way constitute abandonment, the potential lessors were very concerned that a lack of diligence on DFWP's part once the right is leased would result in claims that the lessor's right is somehow abandoned or limited upon reversion to lessor.

19. One of the primary concerns of opponents in the legislative hearings concerning HB 707 was the concern that DFWP would not pay its fair share of water commissioner fees and expenses if a water commissioner was needed to administer the water rights on a stream. Thus, a provision expressly stating DFWP is subject to these types of actions should be added to a lease for clarity. However, regardless of this provision, HB 707 included a provision that Section 85-2-436 and 437 were subject to the provisions of Title 85, chapter 2, part 4. This provision of HB 707 is not codified in the MCA, but is valid law found at Sec. 9, Ch. 658, Laws of Mont. 1989. Section of 85-2-406, MCA, which applies to the water leasing provisions, gives the district court supervision of all water distribution which provisions reference

the appointment of a water commissioner in the event of controversy. Therefore, by law, DFWP is subject to the water commissioner statutes which include apportionment of water commissioner fees and expenses.

20. MacDonnell, "Shifting the Uses of Water in the West: An Overview", p. 26-7, Moving the West's Water to New Uses: Winners and Losers, (11th Annual Summer Program, Natural Resources Law Center, University of Colorado School of Law, 1990).

21. Id.

22. See, O.R.S. Sections 537.455 through 537.500 and 540.510, and Oregon Administrative Rules 690-18-010 to 090. See also, Kreag, "Transferring Conserved Water: The Oregon Experience,", Moving the West's Water to New Uses: Winners and Losers, (11th Annual Summer Program, Natural Resources Law Center, University of Colorado School of Law, 1990).

23. See, MacDonnell, "Shifting the Uses of Water in the West: An Overview", p. 22, Moving the West's Water to New Uses: Winners and Losers, (11th Annual Summer Program, Natural Resources Law Center, University of Colorado School of Law, 1990). See also, the Oregon, Wyoming and Utah laws allowing sale, lease or change for instream flows, respectively found at O.R.S. Section 536.322; W.S. Section 41-3-1001 through 1014; and, U.C. Section 73-3-3.

9. IMPLICATIONS OF LEASE PROVISIONS FOR LEASE COST

This section describes the implications of specific lease provisions for the actual lease cost. The provisions described include those developed by Mark and Richard Josephson in Section 8.

Term and Annual or Lump Sum Payment

The term and type of payment for a lease can obviously vary. On Swamp Creek, Fred Hirschy indicated he would consider a 5 or a 10 year lease term. On Big Creek, the potential lessors may want a term of 20 years to correspond to the life of their investment. Payment may be typically annual or an up-front lump sum. The Big Creek parties indicated a preference for the latter. We agree with the Josephsons that lump sum payments can be derived from annual payments by discounting over the lease term to present value. The relationship of term, payment type and interest rate is given by the formula:

$$A = P * (i(i + 1)^n/((1 + i)^n - 1)$$

where A is an annual payment, n is the term and P is the present value (lump sum equivalent of the annual payment stream). This relationship can of course be solved for P when A is known.

The effect of term on the annual amortized lease cost for the Swamp Creek case was developed previously. In this case, because the agricultural return foregone is increasing over time (as the land comes in to full production), longer term leases have higher amortized annual values. For most cases, unless annual fees are indexed to some measure of inflation (such as the consumer price index), annual fees will probably be independent of the term. The question of whether to agree to an inflation-index adjustment depends on whether it is assumed that agricultural returns will actually increase with inflation over the term of the lease.

When computing up-front lump sum equivalents of a given stream of annual value of foregone agricultural production, the same issue must be addressed. If it is assumed that agricultural net returns to irrigation would keep up with inflation, then it is appropriate to compute P using a real discount rate (4.6 percent is suggested previously, based on the real rate identified by the Montana Department of Natural Resources and Conservation). This is of course equivalent to computing an inflated annual value (growing at some rate of inflation, for example say 6 percent) and using the corresponding nominal or market rate of interest of 10.6 percent. On the other hand, if agricultural returns that we have computed above based on 1987 to 1989 average prices are assumed to be constant in current dollar terms for the life of the lease, then it is appropriate to discount with the nominal rate (which implicitly includes inflationary expectations). This

is an important point for negotiation.

In any case, once agreement is negotiated on the annual lease cost, an appropriate discount rate, and the term, it is straightforward to use the formula given above to compute an equivalent up-front lump sum. Obviously the term and choice of discount rate and expectations about trends in the annual value greatly affect the lump sum value. For an annual lease value of $1000 per year, the lump sum value of a five year lease discounted at 10 percent is only $3,791. The lump sum for a 10 year lease discounted at 4.6 percent and the same annual lease value of $1000 is $7,874.

For cases like Big Creek, one has as a starting point an up-front lump sum value (the DFWP cost share of the irrigation system improvement investment). In this case, annual lease values, if appropriate and agreeable, would probably be based on amortizing the investment cost using a nominal (market) rate of interest. This is because in this case the irrigators, to the extent they are not able to actually cover the investment up-front, will have to borrow at market rates. Accordingly, they would probably negotiate an amortized annual payment from DFWP (for DFWP's cost share) using their actual interest costs. Again, one can compute the annual fee (A) given the lump sum cost (P) using the formula above. For example, suppose the cost is $100,000 present value. At 10 years and 10 percent interest the annual cost is $16,270. On the other hand, a 20 year lease at 4.6 percent is only $7750 per year. Note that it would be possible to negotiate an annual payment schedule (say 10 years) that is different than the life of the lease (say 20 years).

Other Payment Structures

Josephsons identify several other payment structures. One is a dry year or standby lease. In this case the lessor is notified at some point in the year as to whether the lessee will take the water that year. Both Big Creek and Swamp Creek parties have indicated they are not interested in this option. Values for these cases would be case-specific. One would have to compute the value foregone by the rancher of not having water in a given year. This is straightforward only if there are no multi-year effects. For example, one year (or even a month) of not irrigating could damage future crops (of alfalfa, for example) for years to come. Computing a lump sum payment in such a case would be especially complex, as it would have to be tied to expectations about the hydrological cycle.

A variant is a hybrid lease with an up-front lump sum for the option to purchase plus a yearly compensation paid if the option is used. The yearly compensation value in such a case could be derived from the foregone annual production values described above. It would be difficult to tie the value of the option

itself to agricultural production.

Amount of Water and Timing

We suggest in the preceding sections that the best way to derive a total lease value is to look at the foregone agricultural value tied to the land base served by the existing irrigation system. Should less than the full diversionary right be leased (as opposed to protected), some fraction of the full possible foregone production value could be computed. To do so would require site specific hydrology. What should make a difference to the lessor is the actual lost production. Estimating plausible lease values from the amount of water at the point of diversion (the diversion right) is difficult given the variability in the share of diverted water that actually is usefully delivered to the root zone of the crop during the growing period. As noted above, this depends in part on the conveyance and application efficiency of the irrigation system.

Computing the value to having water for just part of the growing season or for a limited number of days over the season will require site-specific investigations. It is possible that there may be few cases where potential lessors would consider partial season leases. This may be especially true for crops like alfalfa where a stand can be permanently damaged by not irrigating for even part of the growing season. As the Josephsons note, some crops need water most of the summer to be of any value at all.

For Swamp Creek, Fred Hirschy has stated that the lease price will be the same whether the lease period is two months or six.

On Big Creek, partial season leasing is also not an attractive option, given that the salvage water is based on a long-term investment. Given the assumption of a fixed scale to the irrigation project, the necessary cost share from DFWP will be independent of whether the water is needed in only one month or six.

As the Josephsons discuss, two provisions of the law limit the water right to be leased: that it can only be for the amount consumed and that the use will not adversely affect other parties. This is a redundancy in the statute in that the only reason for limiting to amount consumed is to avoid adverse affects. In any case, its possible that DFWP and the lessor may both want to lease the full diversionary right. But suppose only half of it is deemed to be "consumed". Does this mean that the rancher has to continue to divert half of his former right? This may do the rancher no good as it may not even be enough to overcome ditch loss and result in measurable irrigation at the field. In this case the production loss is the same as the full right, yet DFWP only gets half the benefits. This is a point of the statute that may need clarification. The purpose for

mentioning it here is to further illustrate that the amount of water leased may, within some range, not affect the lease price.

The Josephsons wisely recommend that for the present the state should select cases where there are no downstream appropriators involved, so there is no need to be concerned about protecting the "consumed" amount. They judge that DFWP has found several such cases in Big Creek and Swamp Creek. In both situations, the potential for adversely affecting downstream junior appropriators is small since there are no junior appropriators in the protected stretch or within a reasonable distance downstream of this stretch.

Miscellaneous

While the focus of this paper is on foregone production value, it appears from discussions with Fred Hirschy that the production loss may be the lesser part of total lease value. Some compensation may be negotiated, perhaps like the bonus payment in oil leases, to overcome the perceived risks and uncertainties in this pilot leasing program. There is a fear, for example, that some entity may try to maintain instream rights upon expiration of the lease. The Josephsons make the recommendation that the state indemnify the lessors for any suits or actions which arise out of the leasing arrangement.

Having a clear provision on this point may yield the state considerable economies in terms of the "bonus" aspect of a total lease price.

9. CONCLUSIONS

The valuation of agricultural water is a complex problem. Unlike markets for many goods, water markets, and agricultural water markets in Montana in particular, are generally spatially constrained. This is due to the high cost of water transport relative to the current market demand for alternative in-state uses. That is, the market for the water primarily exists only on-site or instream. This constraint suggests that lacking examples of comparable leasing activity, water lease prices should be based on potential displaced agricultural production. Two methods of estimating this displaced production value were presented here: county-level historical comparisons and crop-water production function estimates. The production function estimates are only available for alfalfa and provide a good estimate of value per acre foot at the crop. To extrapolate to a total value one needs information on site specific hydrologies. The production function estimates are short run values which are comparable to the short run values estimated using the county comparison approach. For purposes of estimating the value of long term leases long run water values were computed using the county comparison method.

The acre/foot water values estimated using the county historical data method presented in this report are average values. It must be understood that there is considerable variation across farms and farmers perhaps particularly with regard to water availability and thus, wherever possible actual on-site cost and revenue estimates should be used in place of the assumed mean estimates when applying this method.

In general, the county-level comparison method should be used for the estimation of per acre water values. These per acre values do not make the questionable assumption that all crops meet their maximum ET needs and thus are more reliable than the per acre/foot values which do rely upon this assumption. The production function method of water valuation can be used to determine acre/foot water values for irrigated alfalfa hay.

References

Bjergo, Allen. Personal communication. October, 1990.

Colby, B.G. 1989. Estimating the Value of Water in Alternative Uses. Natural Resources Journal. Vol. 29, Spring, 1989.

Fogel, V. and Luft, L. 1980. Enterprise Costs in Missoula County. Cooperative Extension Service, Montana State University, Bozeman. Bulletin 1242.

Gibbons, D.C. 1986. The Economic Value of Water. Resources For The Future. Washington, D.C..

Greiman, William, G. 1990. Computer Aided Evaluation of the Value of Water for Irrigation. Master Thesis. Department of Agricultural Engineering, Montana State University, Bozeman.

Fredrick, K.D. and Hanson, J.C. 1982. Water for Western Agriculture. Resources for the Future. Washington, D.C..

Lacewell, R.D., J.M. Sprott and B.R. Beattie 1974. Value of Irrigation Water with Alternative Input Prices, Product Prices, and Yield Levels: Texas High Plains and Lower Rio Grande Valley, Texas Water Resources Institute Technical Report no. 58. College Station, Texas.

Montana Department of Natural Resources and Conservation, 1989. The Montana Irrigator's Pocket Guide. Montana DNRC, Helena, Montana.

Montana Department of Natural Resources and Conservation, 1989. "DNRC Water Reservations Economic and Financial Evaluation; Irrigation Projects". Mimeo.

USDA Soil Conservation Service. Montana Irrigation Guide. USDA Soil Conservation Service, Bozeman, Montana.

USDA Soil Conservation Service. Montana Irrigation Manual. USDA Soil Conservation Service, Bozeman, Montana.

Water Market Update. Steven J. Shupe Editor. Shupe and Associates, Sante Fe, NM.

Young, R.A. 1984. Local and Regional Economic Impacts. in Water Scarcity Ed. Ernest Engelbert. University of California Press, Berkeley, CA.

Young, R.A. and S.L. Gray, 1972. Economic Value of Water: Concepts and Empirical Estimates. Report to the National Water Commission. National Technical Information Service. Springfield, VA.

APPENDIX A: Acre/Foot to Cubic Feet Per Second Conversions

Units of water can be measured in two ways; as a stock or specific volume of water at rest, or as a flow of water over a period of time. The water values presented in this report are given for acre/feet of water, a stock amount. It may be of interest, however, to know how an acre foot value translates into the terms in which water rights are often granted, namely, cubic feet per second or miner's inches (in Montana one Miner's inch is 1/40th of a cfs).

In order to translate acre/feet into cubic feet per second two pieces of information are necessary. First, and obviously, one needs the original number of acre/feet to be translated. Second, one must know the length of time over which the flow will be allocated. The following equation shows the form of the transformation.

$$CFS=\frac{Acre/Feet \times .5042}{Number\ of\ Days}$$

Conversely, in order to translate cubic feet per second into acre/feet the following transformation is employed.

$$Acre/Feet = CFS \times 1.9835 \times Number\ of\ Days$$